Compressed Air Magazine

WORLD'S RECORD CANTILEVER SPAN

Greater New Orleans Bridge Is Longest Of Type Spans 2.3 Miles

JULY 1958

NEW YORK • LONDON

COPPUS "BLUE RIBBON" VENTILATORS

Used in wide variety of applications throughout industry

Improve workers' safety . . . health . . . comfort . . . efficiency

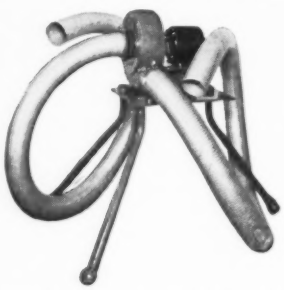
VANO DESIGN "A" VENTILATOR is used here during repairs to a chemical still. This type ventilator is used to ventilate tanks, tank cars, drums, vats, underground cable manholes, pipe galleries, airplane wing compartments, fuselages and other confined places. Uses 8″ diameter flexible canvas tubing ("Ventube").

VANO DESIGN "B" VENTILATOR here discharges welding fumes from double-bottom compartment in naval vessel under construction. Large volume of air handled quickly expels fumes and results in good ventilation. Vano Design "B" can pass through opening only 14″ in diameter. Uses 8″ diameter flexible canvas tubing ("Ventube").

VANO DESIGN "C" VENTILATOR here withdraws fumes from a reactor kettle. This ventilator can be furnished with 8″ suction inlet for 8″ non-collapsible suction tubing — or multiple inlet nozzles for 5″, 4″, and 3″ suction hose. The discharge may be connected to 8″ "Ventube." Capacities furnished on request.

NO. 2 AEROPLANE HEAT KILLER here directs cool, fresh air on worker in drop forge plant. Heat killers restore workers' efficiency by providing extra ventilation in the hot months, or on any job where workers are continually or periodically required to work in excessive heat. Available in two types, three sizes in each.

VENTAIR DESIGN TE-4 VENTILATOR Gasoline Engine Driven, here delivers air into underground manhole. These ventilators provide fresh air to men in confined places, promoting safety, comfort, and increasing efficiency. Ideal where no electric current is available. Delivers 1700 CFM of fresh air. Uses 8″ diameter flexible canvas tubing ("Ventube").



PORTAIR NO. 4 BLOWER EXHAUSTER exhausts fumes resulting from soldering, welding, tank coating, is also used in ventilating small tanks. It is designed to permit attachment of 4″ flexible metal hose. Capacity: 425 CFM free air.

ATTACH THIS COUPON TO YOUR COMPANY LETTERHEAD

COPPUS ENGINEERING CORPORATION, 207 PARK AVENUE, WORCESTER 2, MASS. Sales offices in Thomas' Register. Other "Blue Ribbon" Products in Chemical Engineering Catalog, Refinery Catalog, Best's Safety Directory and Mining Catalogs.

Please send me information on supplying fresh air to men working:

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes
- ☐ in aeroplane fusilages, wings, etc.
- ☐ on coke ovens
- ☐ on steam-heated rubber processes
- ☐ on boiler repair jobs

COOLING:

- ☐ motors, generators, switchboards
- ☐ wires and sheets
- ☐ general man cooling
- ☐ around cracking stills
- ☐ exhausting welding fumes
- ☐ stirring up stagnant air wherever men are working or material is drying
- ☐ drying of walls, sheets, etc., after treated with coating material

Name .....

Company .....

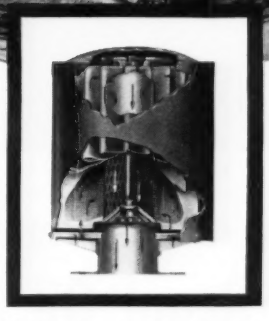
Address .....

City .....Zone....State.....

Write here any special ventilating problem you may have { _____ _____

KEEP IT CLEAN by Phil Tration

In searching for sea-buried treasure,
Consider the worth of this measure:
When oxygen's rare, just filter fresh air
Through Staynew for deep-breathing pleasure.



Thank goodness you don't have to search so deep and far to find uses for Dollinger Filters. Any liquid, any gas (you name it) can be efficiently and economically handled by them. You'll find applications everywhere: in pipelines to prevent damage by rust and dirt; in ventilating systems to reduce air-borne impurities; on compressors and engines to prevent cylinder and piston damage by foreign matter. Let us know your filtration problems.

STAYNEW MODEL D AIR INTAKE FILTER

If you want to keep dirt and dust out of Diesel engines or compressors, nothing does the job better than the Dollinger Intake Filter illustrated. Its efficiency actually increases with use, therefore no rigid maintenance schedule is necessary. Many Dollinger Intake Filters are in operation for two or more years without attention. Write for Bulletin 100. Dollinger Corporation, 7 Centre Park, Rochester 3, N. Y.

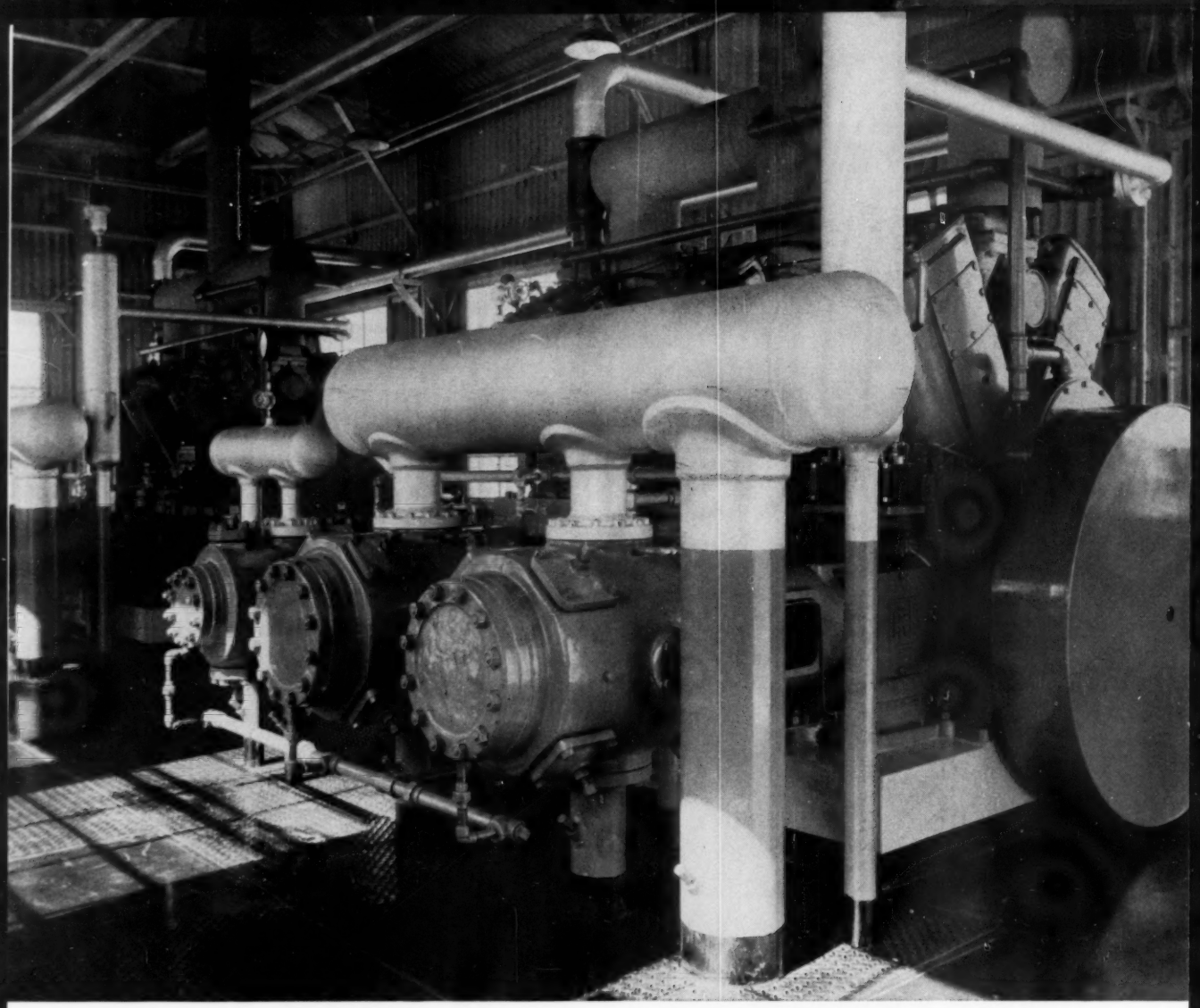
REG. PROTECTOMOTOR U.S. PAT. OFF.

STAYNEW FILTERS

DOLLINGER

SPECIALIZING IN DRY TYPE FILTERS FOR OVER 35 YEARS

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS HIGH PRESSURE FILTERS • AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS



No Rust and Sludge because...
Texaco Regal Oil R&O keeps compressors clean

Additives in Texaco Regal Oil R&O prevent formation of rust and sludge, keep maintenance costs down. Valves and lines remain clear, and rings are free from harmful deposits. As a result, efficiency stays high... performance is always dependable.

There is a complete line of Texaco Regal Oils R&O, all refined to premium quality. Your Texaco Lubrication Engineer will be glad to help you select the right Texaco lubricants to keep *your* air compressing system clean. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)

Compressed Air Magazine

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July 1958

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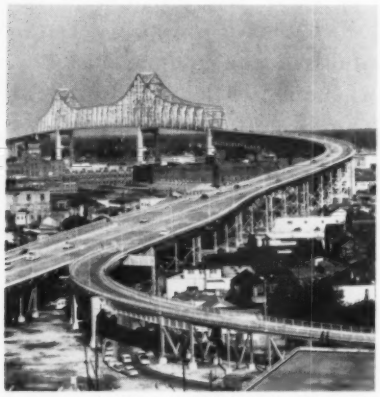

PHOTO, ALUMINUM COMPANY OF AMERICA

ON THE COVER

KEY structure in New Orleans' traffic pattern, the new bridge shown on our cover this month is expected eventually to carry some 18 million vehicles per year. Fifty-two feet wide, the span is now divided into four 12-foot lanes. When expected increases in traffic come, there will be five lanes, the center one of which can be controlled for flow in either direction. Including its approaches, the structure is 2.3 miles long, utilizes some 600,000 pounds of aluminum in gratings, railings, lighting standards and inspection walks to lighten dead loads and facilitate maintenance; and was designed by Modjeski & Masters. Expected to carry about 8,000,000 vehicles in its first year of operation, the Mississippi River crossing is owned by the Mississippi River Bridge Authority.

FEATURE ARTICLES

Page 10 **Automatic Compressor**—*C. H. Vivian*
The Northern Natural Gas Company has placed two, automatic 1320-hp gas-engine-driven compressors in operation at its Hooper, Neb., station. Although oil-line stations have long had automatic control, it is a relatively recent development on gas lines. The firm foresees worthwhile economies in automatic control.

15 **Injection Program Continues**—*G. R. Smith*
Creole Petroleum Corporation has completed its second gas-injection station on a platform in Venezuela's Lake Maracaibo. Tia Juana No. 2 will increase by one-third the amount of petroleum recovered from the oil strata it serves.

18 **Bulbous Buildings**—*S. M. Parkhill*
Inflatable buildings, originally designed to house radar equipment, are now growing in popularity. A Minnesota concern has built a number of these interesting structures for a variety of purposes.

22 **Something About An Eagle**
The bald eagle is the symbol of American strength. Some of the facts and legends connected with the bird are related.

26 **Bat Cave**
A $10 million bat guano deposit is being mined in the Grand Canyon.

26 **Channeled Hortonclad**
Heavy composite plates can be used as a heat-transfer medium because of a vacuum cladding development.

27 **Fluid Transporter**
Ten baggy tires carry 5000 gallons of fluid.

28 **Pneumatic Hold-Down Beams Eliminate Feed Problems**
Air power aids sizing of plywood panels.

28 **Mobile Sump Cleaner Utilizes Vacuum And Air Pressure**
A recently developed machine cleans sumps and settling tanks on machine tools.

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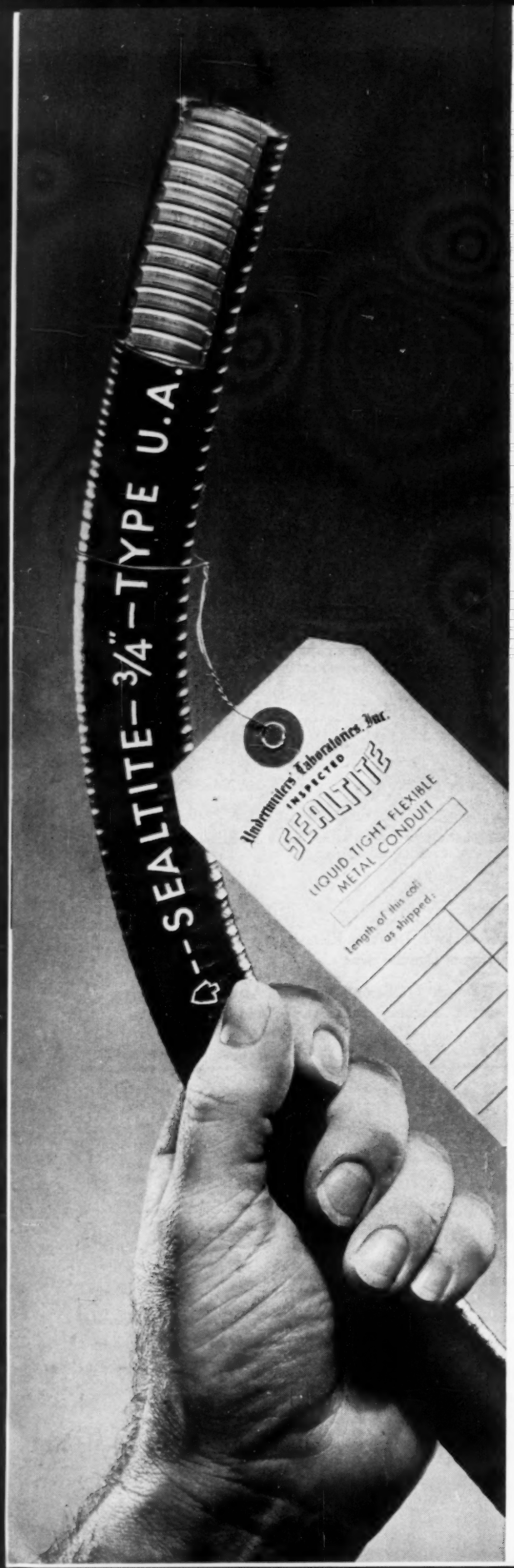


On the roughest SEALTITE electrical

against oil, grease, water, dirt, chemicals, corrosive fumes, salt spray, weather.

SEALTITE is a flexible *and* liquid-tight electrical conduit. It gives maximum protection to your wiring when it must connect moving parts, absorb vibration, follow machine contours, flex into U-bends, be easily maintained or be safeguarded between misaligned outlets.

It is being used successfully in wet locations, in tunnels, power plants, steel mills, canneries, chemical industries and in many outdoor applications. Sealtite comes in three types:

TYPE U.A.— TYPE C.S.A. Specifications for Type U. A. (Underwriters' Laboratories Approved) and Type C. S. A. (Canadian Standards Association Approved). Construction: flexible galvanized steel core, positive ground and tough extruded outer cover.

TRADE SIZE	INSIDE DIAMETER		OUTSIDE DIAMETER		APPR. INSIDE BEND DIAM.	EST. WGT. (Lbs. Per 100 Feet)
(Ins.)	Min.	Max.	Min.	Max.		
⅜	.484	.504	.690	.710	6	30.0
½	.622	.642	.820	.840	7	36.6
¾	.820	.840	1.030	1.050	10	48.2
1	1.041	1.066	1.290	1.315	12	87.7
1¼	1.380	1.410	1.630	1.660	15	116.5

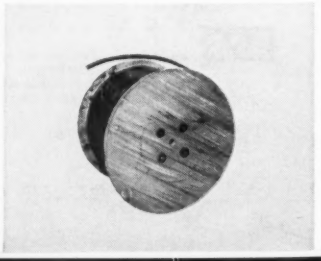
TYPE E. F. † (Extra Flexible)—for machine tools and industrial equipment. (Meets standards set by J.I.C.)

TRADE SIZE	INSIDE DIAMETER		OUTSIDE DIAMETER		APPR. INSIDE BEND DIAM.	EST. WGT. (Lbs. Per 100 Feet)
(Ins.)	Min.	Max.	Min.	Max.		
⅜	.485	.500	.695	.710	5	24
½	.620	.635	.825	.840	5	29
¾	.815	.830	1.035	1.050	6	39
1	1.030	1.050	1.295	1.315	8	67
1¼	1.370	1.390	1.635	1.660	10	87
1½	1.575	1.595	1.875	1.900	12	105
2	2.020	2.040	2.350	2.375	15	135
2½	2.480	2.505	2.850	2.875	20	198
3	3.070	3.100	3.470	3.500	26	282
4	4.000	4.040	4.460	4.500	34	414

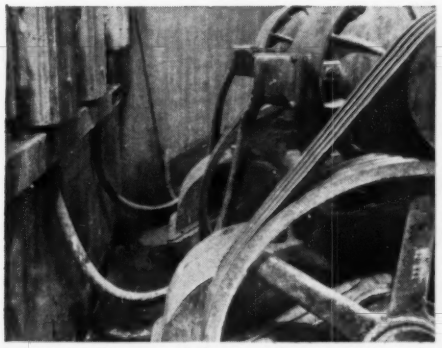
Commercial tolerances apply on above figures.

ELECTRICAL WHOLESALERS stock Sealtite. Buy it in long, random lengths on nonreturnable wooden reels, at no extra cost. Available in sturdy cartons that are easier to store and carry to the job. Liquid-tight connectors also are available from wholesalers' stocks. For information write: The American Brass Company, American Metal Hose Division, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

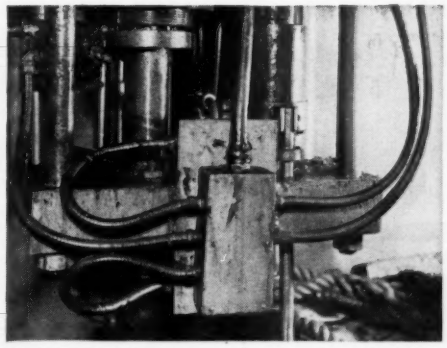
†Pat. applied for 58182 Rev.



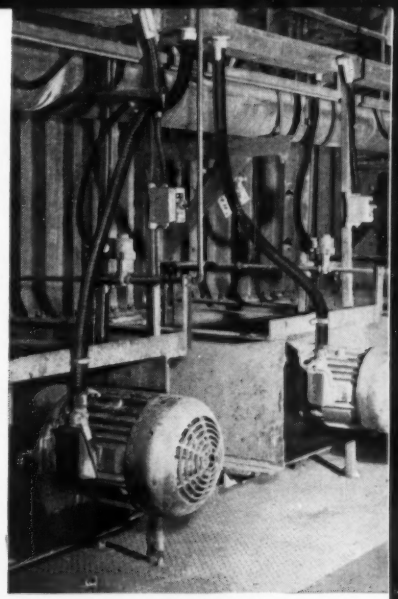
jobs in your plant conduit protects wiring



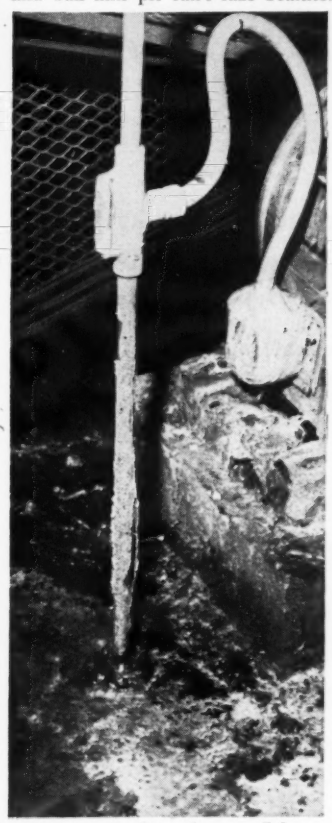
ABRASIVE GRIT around these sand pumps in a rod and ball mill pit can't faze Sealtite.



OIL, GREASE, WATER constantly cover these Sealtite control connections. Still no trouble.



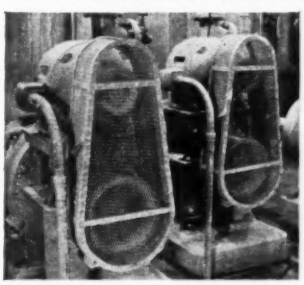
BOILER HEAT and 6-inch expansion rise are easy service for Sealtite.



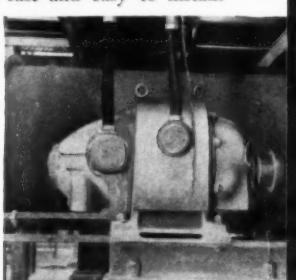
CHEMICALS. Sealtite shrugs off hot chlorine vapors in this plant—another example of its ability to resist chemicals and corrosive fumes.

WEATHER. Install Sealtite outdoors. It stands up under tropical sun and heat, rain, ice, and arctic cold. Protection is complete.

ON MOBILE EQUIPMENT Sealtite can take up movement, withstands weather, dust, vibration. It's fast and easy to install.



MOVEMENT AND VIBRATION that would crack rigid conduit are absorbed by Sealtite on connections for these tailings pumps.



ABRASIVE DIRT AND VIBRATION at this ball mill motor are tough enemies—but Sealtite can take it.

CUTAWAY SECTION of Type U.A. Sealtite shows tough polyvinyl jacket over flexible metal core. Copper conductor wound spirally inside conduit gives positive ground.

Insist on the conduit marked **SEALTITE®**

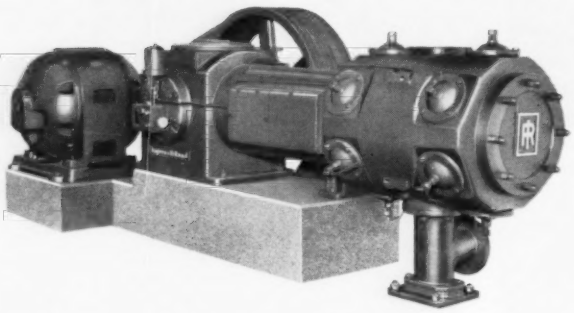
FLEXIBLE, LIQUID-TIGHT CONDUIT

an **ANACONDA®** *product*

NEW COMPRESSORS

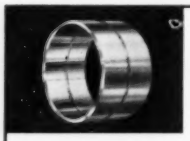
...with heavy-duty features proven in larger Ingersoll-Rand compressors

ESH* (horizontal)



ESV* (vertical)

*The same compressor in either horizontal or vertical arrangement – 20 to 150 hp sizes, single-and multi-stage, pressures up to 5000 psi and vacuums.



Full-floating aluminum bearings never need adjustment

The full-floating bearings "roll with the punch," taking each thrust on a different portion of the shell. They are foolproof, and never require fitting or adjustment. Main and crankpin bearings are made of I-R's special aluminum bearing alloy, which has higher load capacity and better heat conductivity than other bearing materials.

Air-cushioned Channel Valves give unmatched performance

Known the world over for lasting efficiency, dependability and quiet operation, Ingersoll-Rand air-cushioned Type A Channel Valves are entirely different in design and principle from any other valves in use. Type A Channel Valves were developed especially for modern compressor speeds, and feature a separate stainless-steel seat plate which can be reversed or replaced for new life.

Never a need for adjustments– frame is kept sealed!

Here's an entirely new line of compressors, built to run longer — much longer. They're more compact, more efficient, and require less attendance, less maintenance. They offer greater capacity in less space, and are ruggedly built and highly refined to take years of continuous hard service.

All running parts are precision-machined and need no fitting or adjusting, so the frame is sealed — dirt stays out, and the major causes of wear are eliminated!

There are many design features—including filtered force-feed lubrication and full-floating self-adjusting metallic packing — that have heretofore been found only in larger Ingersoll-Rand compressors. Let your I-R representative tell you more about these new compressors, and how they can save you money.

Ingersoll-Rand

I-815

11 Broadway, New York 4, N. Y.

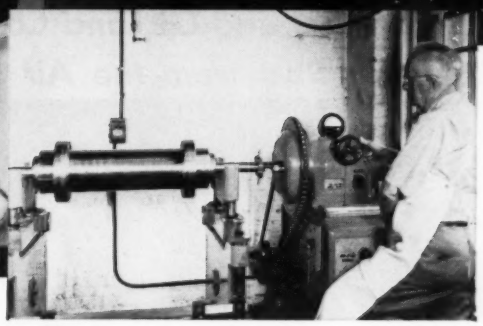
In engineered products, there's no substitute for experience!

COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

HIGH SPEED DRIVES CALL FOR
JOHN WALDRON High Speed Couplings

1 Unfinished forging for Waldron High Speed Coupling.

2 Machining operation on Waldron High Speed Coupling at New Brunswick Plant.



3 Dynamic Balancing of High Speed Coupling.

Today's high speed turbines and turbine-driven compressors are built like fine watches. They have to be to stand up under the terrific strains and stresses of the greater velocities. Good materials, accurate machining and balancing are essential to their service life and efficiency.

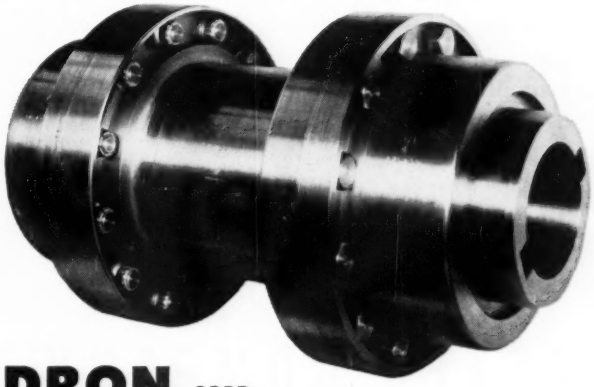
Equally important in the efficient operation of this equipment is the coupling—the power link between the turbine and the compressor. That's the reason for the extreme care in the manufacture of all Waldron High Speed Couplings.

John Waldron uses quality forgings made from SAE 4140 steel, heat treated to a Brinnell of from 285 to 315 on the outer sleeves and 225 to 255 on the hubs. This gives a good operating differential in hardness which is considered beneficial for the longer service life a high speed coupling requires.

The John Waldron method of balancing serves as a double check on the accurate machining. The nuts and bolts are all weigh balanced, the hubs are balanced separately and the complete unit is balanced on an arbor and match marked for ease in reassembly.

The result is a perfectly made and balanced coupling—and one that stresses material, workmanship and design.

4 Assembling High Speed Coupling.



JOHN **WALDRON** CORP.

A unit of J. O. Ross Engineering Division
Midland-Ross Corporation
New Brunswick, New Jersey

Drilling river-bottom limestone for Amherstburg Channel

This huge drill boat, the M-1, using Bethlehem Hollow Drill Steel, is operating in the lower Amherstburg Channel of the Detroit River, near Amherstburg, Ontario. It is drilling and blasting rock in preparation for dredging in modernizing the Connecting Channels of the Great Lakes.

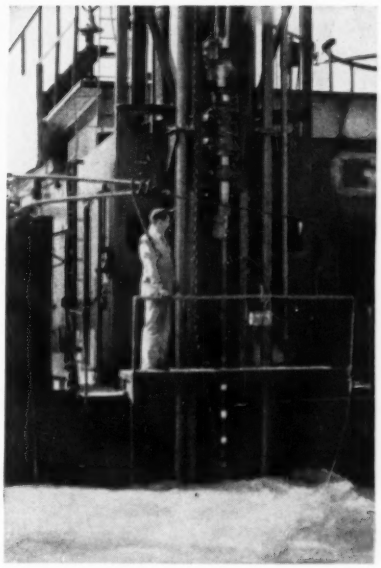
Great Lakes Dredge & Dock Co. is one of the contractors on this phase of the Great Lakes Connecting Channels project. Working under the supervision of the U. S. Army's Corps of Engineers, Detroit District, they are moving about 897,000 cu yd of medium-hard limestone in deepening the westerly half of the existing 600-ft wide channel from 21 ft to 28.5 ft. In drilling holes averaging 9 ft in depth, the 3-in. round Bethlehem Hollow has given its usual dependable performance.

Bethlehem Hollow is rolled from fatigue-resistant steel. It has a uniform hole, centrally located in the bar. It also has a wide quenching range, and can be heat-treated easily for the proper balance of toughness and wear-resistance.

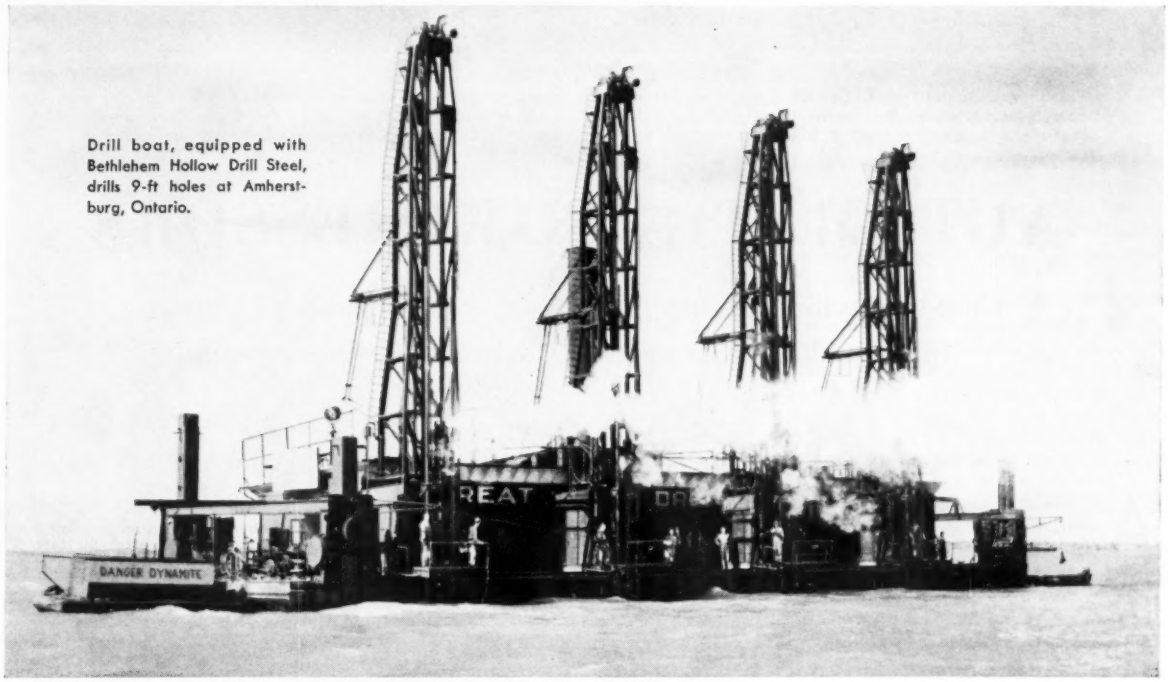
Bethlehem Hollow comes in standard sizes of rounds, hexagons and quarter octagons in both Carbon and Ultra-Alloy grades. It is furnished in lengths of from 18 ft to 27 ft. Call us about your requirements.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation



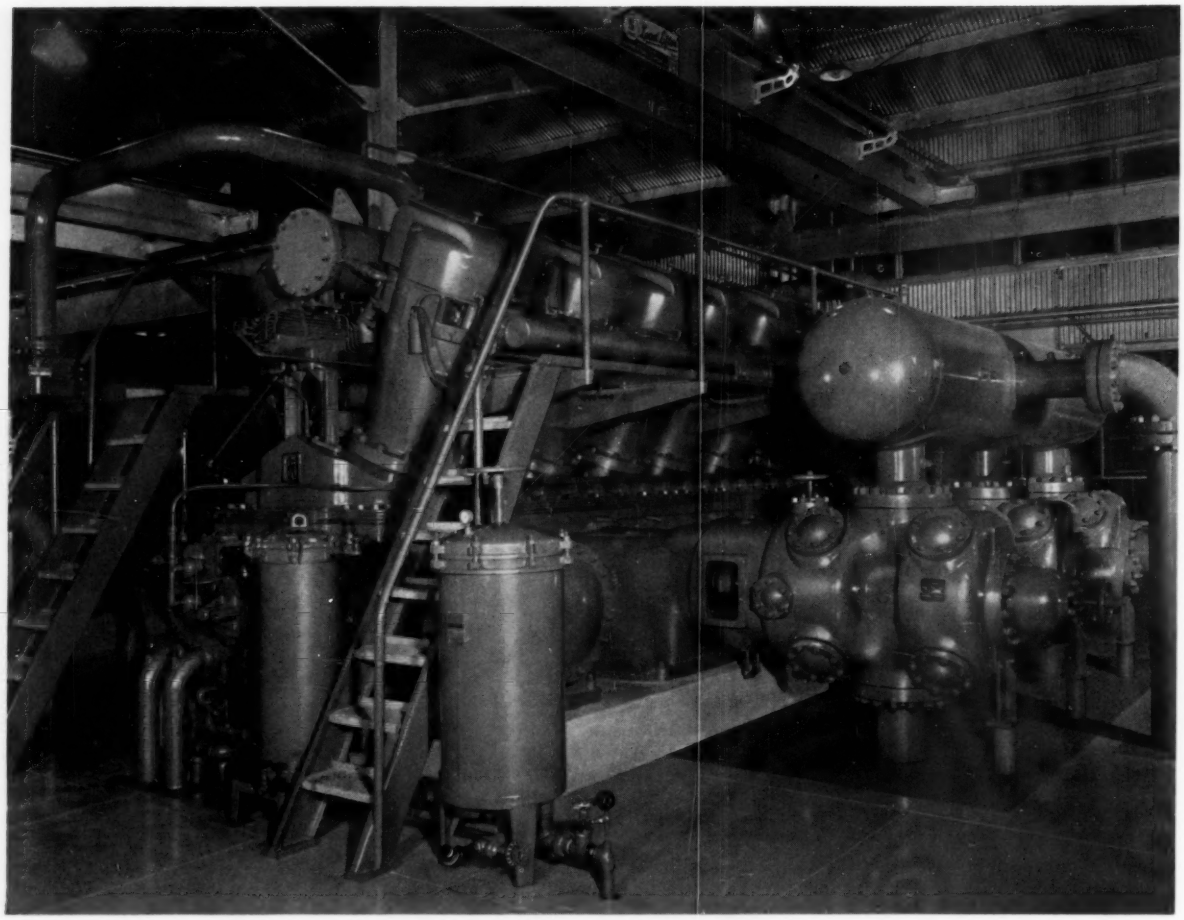
Contracting officer: Col. Peter C. Hyzer;
Resident Engineer: Fred Smith;
Project Engineer: M. E. Lemmerhirt.



Drill boat, equipped with Bethlehem Hollow Drill Steel, drills 9-ft holes at Amherstburg, Ontario.

BETHLEHEM HOLLOW DRILL STEEL

CARBON AND ULTRA-ALLOY



INSTRUMENTS WATCH OVER IT

This Ingersoll-Rand Type KVG 1320-hp, 4-cycle gas-engine compressor is under the control of an inanimate system that starts it, watches over it while it runs and shuts it down. All steps required are carried out in proper sequence, and if anything goes wrong an alarm sounds; if serious, the machine is shutdown before it can harm itself.

AUTOMATIC COMPRESSORS

1320-hp Machines On Northern Natural Gas Company Pipeline In Nebraska Are Completely Controlled By Instruments

C. H. VIVIAN

AUTOMATIC control of mainline compressor stations of natural gas transmission systems is no longer considered a novelty or experiment by men in the industry. Although they are a new development on gas lines, they have been used for several years on lines that carry oil.

The caution that management previously displayed over the idea of trusting expensive equipment to robot attendants is little in evidence now. On the contrary, there is a feeling that large capital investment deserves, and should have, the protection afforded by automatic control, with its freedom from the possibility of human errors.

The increasing competition that natural gas is facing as a fuel is expected to hasten the growth of full-station automation. Rising costs, both of the gas itself and of its transportation, have led to higher rates for gas consumers and narrowed the considerable advantage in price that gas once enjoyed over other fuels. This has prompted gas-line managements to urge their engineering and operating departments to reduce building and operating costs. Thus pushed, the technical men are, in turn, studying the possible economic benefits of automation.

It is logical to assume that the forthcoming completely automatic stations will be newly built ones. Meanwhile, experience is being gained by applying automation to newly installed compressors in existing manually controlled stations. One of the leaders in this

movement is Northern Natural Gas Company, which operates an 11,535-mile transmission system and serves 880,260 customers in 387 communities in the Northern Plains States of Minnesota, Iowa, Nebraska, South Dakota and Kansas.

Northern Natural has two automatic Ingersoll-Rand 1320-hp, gas-engine-driven compressors in operation at its Hooper, Neb., station, which will be described here. (It also has two I-R 2000-hp automatically controlled units at both its Beaver, Okla., and Palmyra, Neb., stations. Those at Palmyra are in a new building and are operated from a separate structure 200 feet away.)

Northern Natural foresees worthwhile economies in automation because: (1) with a complete station under automatic control, it will be possible to add units without increasing operating personnel; (2) automatic machines are easier and more convenient to operate than those that must be manually controlled; and (3) they are fail-safe.

AUTOMATIC CONTROL IN 1897

An "automatic powerhouse" was described in an 1899 catalogue of Ingersoll-Sergeant Drill Company, one of the predecessor concerns of Ingersoll-Rand Company. It was located at Toad Hollow, near Bradford, Pa., and included an Ingersoll-Sergeant straight-line, single-cylinder air compressor. Steam for driving it came from a horizontal return tubular boiler at 90-psig pressure. After cooling water circulated through the jacket of the compressor, it flowed into a small buried tank from which exhaust steam ejected it into the boiler, via a feedwater heater.

Natural gas was burned under the boiler and regulated automatically to hold the desired steam pressure. If the boiler water level got low, a whistle sounded. If it got still lower, a trip automatically shut off the gas. The plant required no attention after being started, except filling of the oil cups occasionally. These lubricated the compressor automatically, feeding drop by drop as required, in plain sight. The plant began operating in 1897, and the air was used for producing oil from the ground. It was piped to 126 wells and pumped from two to six of them at a time in turn. The schedule called for pumping each well twice a week.

The control system that is exemplified by the Hooper station installation provides a completely automatic means of starting, operating and shutting down the engines. It consists, in the case of each of the dual installations, of a control station or panel, an engine-compressor equipped with various temperature and pressure sensing devices and several automatic valves in the gas-transmission, engine-fuel and air-starting lines.

A touch of a button initiates a series of timed steps that starts the machine, loads it and brings it up to speed. Another touch shuts it down, again in ordered steps. All the time it is running, instruments watch over it and protect it against damage, even to shutting it down if it is endangered from any of numerous causes. Continuous monitoring and alarm facilities permit immediate diagnosing of trouble at an early stage when it can be corrected before it becomes serious.

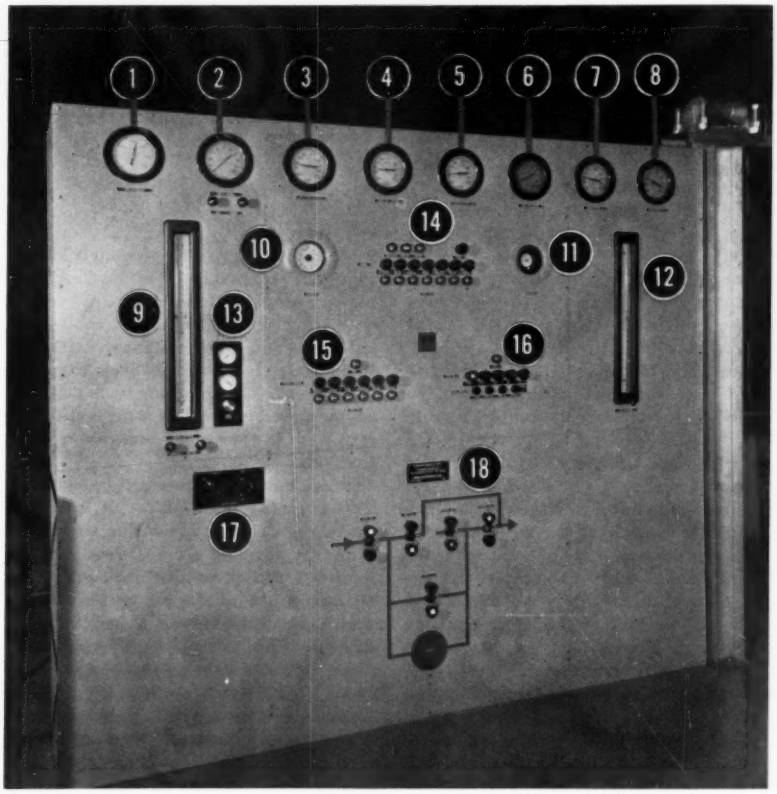
The control system was worked out jointly by the engineering staffs of Northern Natural and Ingersoll-Rand. The control panel was designed and built by a specialist in industrial controls. It has three major circuit subdivisions, identified respectively as "Start-Stop," "Warning" and "Shut Down" control elements. Each is properly related to the whole.

The engine-compressor is a standard Type KVG unit such as is found on many of the nation's trunk line gas carriers and in other gas field and refinery applications. It has twelve power cylinders, each 15¼x18 inches, arranged in V design, direct-connected to three horizontal compression cylinders, each 11½-x15 inches.

The system provides for these five phases of control:

Starting—After the compressor has been purged of air and pressurized, the engine is started and brought to a predetermined minimum speed. When minimum engine operating temperature is reached, the compressor is put on the line.

Normal Speed—By remote loading of the engine governor from the control panel, the operator may reset the speed of the engine to meet the demand for gas.



PHOTO, VIKING INSTRUMENTS, INC.

INSTRUMENT PANEL

This panel contains the control instruments as well as gauges and indicators that show all operating conditions at a glance. The key to the numbers: (1) Starting air pressure. (2) Lubricating oil pressure. (3) Lubricating oil temperature entering cooler. (4) Lubricating oil temperature leaving cooler. (5) Oil cooler water temperature. (6) Jacket water pressure. (7) Jacket water temperature—inlet. (8) Jacket water temperature—outlet. (9) Manifold depression. (10) Tachometer. (11) Engine hours. (12) Fuel gas pressure. (13) Instrument air, control air, speed control. (14) "Warning" signals and controls. (15) "Emergency" signals and controls. (16) "Start-Stop" signals and controls. (17) Master control—power, stop, start, off. (18) Compressor valve indicators and controls.

Warning—Abnormal operating temperatures or pressures are indicated by corresponding signal lights on the control panel and the sounding of a horn.

Emergency—If the abnormal conditions just referred to grow more serious, the engine will be shut down immediately, and all components of the system returned to starting position, but auxiliary equipment (water pump, oil pump, air filter, cooling tower fans) will continue operating for 10 minutes. The control panel is also equipped to indicate, by means of lights, the exact cause of the shutdown.

Normal Shutdown—Pressing a stop button initiates a succession of timed operations to slow the engine, take the compressor off the line and then stop the unit. All components of the system are returned to starting positions except the auxiliaries, which continue to operate for 10 more minutes and are then shut down.

Although operation is usually automatic, an override device permits operating individual switches manually and independently of the control panel. When under manual control, the unit is still protected by basic safety devices built in by the manufacturer. These will shut the engine down by grounding the magnetos in case of overspeed (above 365 rpm), overheating (water above 200°F) or insufficient oil pressure (less than 20 psig).

The control system functions in conjunction with five hydraulically operated valves on the gas lines in the yard outside the station. These are: a suction valve that controls the admission of gas from the incoming line to the compressor intake; a discharge valve that controls admission of gas from the compressor to the outgoing station line; a purge valve that controls the admission of gas to the compressor cylinders to purge and pressurize the compressor prior to starting; a blowdown or vent valve that opens when the compressor is not running; and a bypass valve that opens to bypass gas through the compressor while it is warming up after starting.

When the compressor is to be started, it is ascertained that the five switches controlling the valves and four switches that can be used when desired to operate auxiliary equipment manually, are in "Automatic" position. The first move is to close a "Power On" switch. A green light on the panel then indicates that the power is on. At this stage the suction, discharge and purge valves should be closed and the bypass and blowdown valves open. If they are not in these positions, they will automatically index to them.

Next, the "Start-Stop" switch is turned to "Start." This sets the sequence of starting operations in motion. First, a 3-hp auxiliary lubricating-oil pump and a circulating water pump are started. The lube oil pump delivers oil to the engine during the starting sequence at less than 20-psig pressure. Later, when the engine starts, the regular engine-driven lubricating oil pump comes into action and the auxiliary pump is shut down.

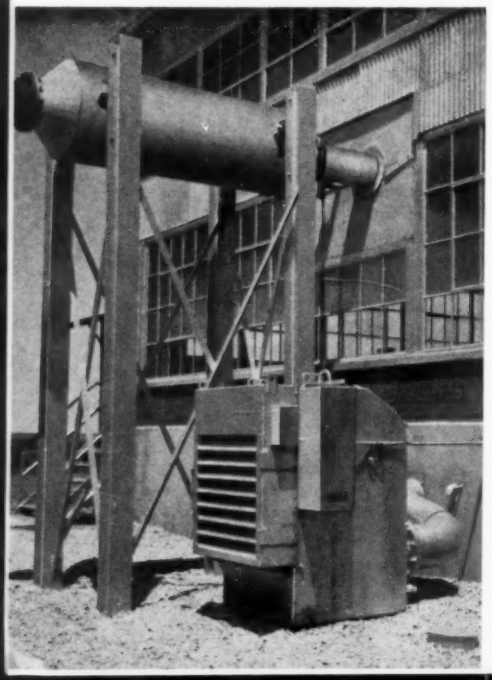
The fans in the cooling tower through which engine and compressor cylinder jacket circulating water is cycled can be started automatically at this time or, if it is desired to save power, by pressing a button a few minutes later when the water temperature gets up to around 100°F.

After approximately 3 minutes, to allow for engine prelubrication by the auxiliary lube oil pump, the purge valve opens and the bypass valve closes to cause purging gas to flow through the compressor. Ten seconds later, the bypass valve opens and the blowdown valve closes. Three seconds later, during the elapse of which the compressor is being pressurized through the purge valve, the discharge valve opens and the purge valve closes.

Compressed air for starting the engine is then admitted to the cylinders and, after 10 seconds of cranking, the ignition is turned on. This is indicated by a green panel light. Three seconds later the engine fuel is turned on and shown by a green light. When the engine fires, starting air is turned off and the engine lubricating oil pressure builds up to 40 psig. A solenoid supplying compressed air at 5-psig pressure to the pneumatic governor is energized, and the engine now runs at minimum speed of 200 rpm and the bypass valve remains open. After the unit has run long enough for the engine oil temperature to reach 100°F, the compressor is loaded by the hydraulic suction valve opening and the bypass valve closing. The operator turns the speed-control knob to increase the pressure of air to the governor to 20 psig, the engine speed goes up to a normal of 330 rpm and the governor maintains it at that rate.

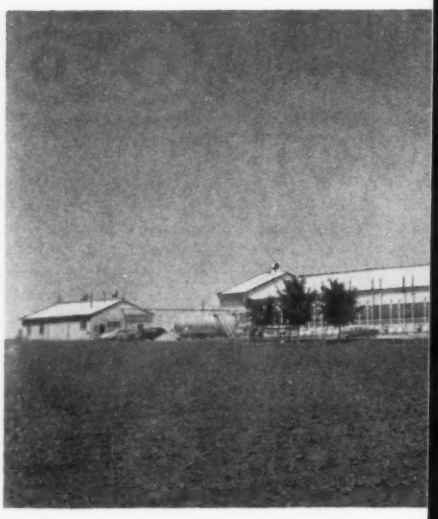
This completes the starting sequence as it normally takes place. If, however, the engine does not fire within 45 seconds after the starting air is turned on, the failure of the oil pressure to come up to 40 psig shuts off the air and closes the fuel gas supply valve. A red light indicating "Failure to Start" comes on, green lights indicating ignition and fuel "On" go off, with accompanying sounding of the alarm horn. Reset buttons above the sequence lights and emergency shutdown lights must then be pushed to initiate another starting cycle.

To shut down the running unit, the automatic sequence takes place essentially in reverse order to the starting sequence. Turning the "Start-Stop" switch to "Stop" de-energizes the governor air solenoid and slows the engine to minimum speed. A green light, indicating that the governor air is on, goes out. Next, the suction valve closes and the bypass valve opens. After one min-



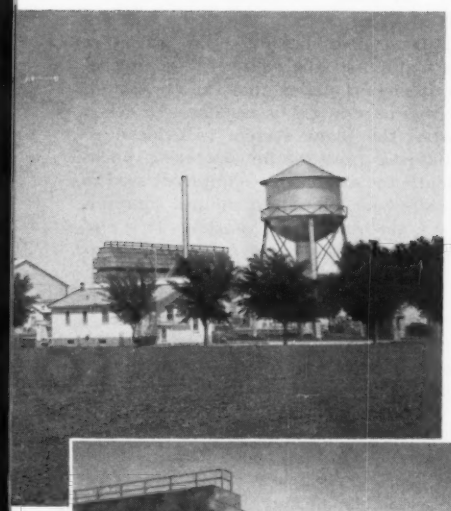
AIR FILTER

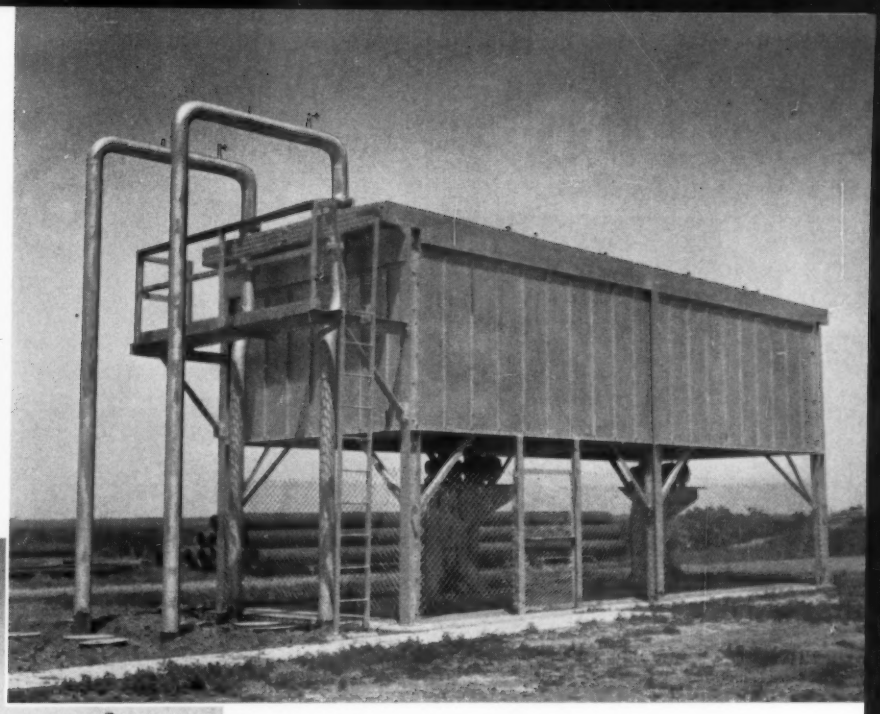
To prevent dust from entering the combustion chambers of the engines that drive the compressors, air is filtered before being drawn into the interior and piped to the machines.

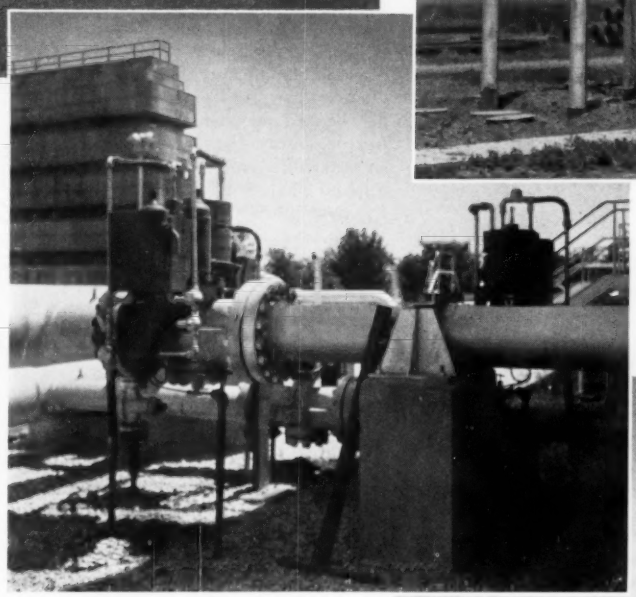


HOOPER STATION

Built in 1942, it is located about 50 miles from Omaha, Neb., on an alternate or loop line of the Northern Natural Gas Company and is normally operated with a light load except during cool weather, when the demand for gas for space heating rises. From the left, the buildings are a machine shop-warehouse, compressor building and office. Beyond the office is the upper portion of the cooling tower that serves most of the compressors. On the right is a water tank that supplies the station.





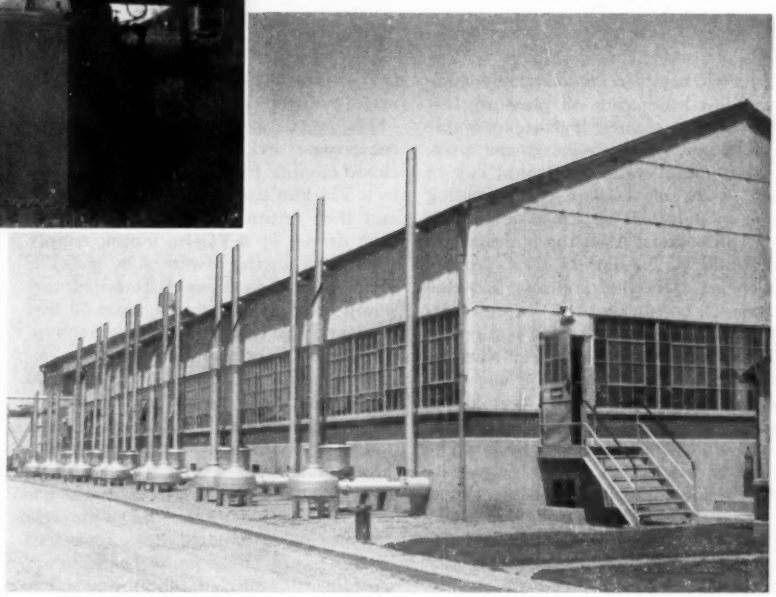


FIN-FAN COOLING TOWER

The water that cools the KVG engine and compressor cylinders is itself cooled here and returned to the station for another circuit. In this 2-cell tower, the water circulates through piping in the upper portion and is cooled by air blown upward by two blade-type fans located underneath.

VALVES ON PIPELINE

These five hydraulically operated valves located just outside the compressor station are tied into the control system. If they are not in their proper positions when the engine starting sequence is initiated, they will automatically move to them.



COMPRESSOR BUILDING

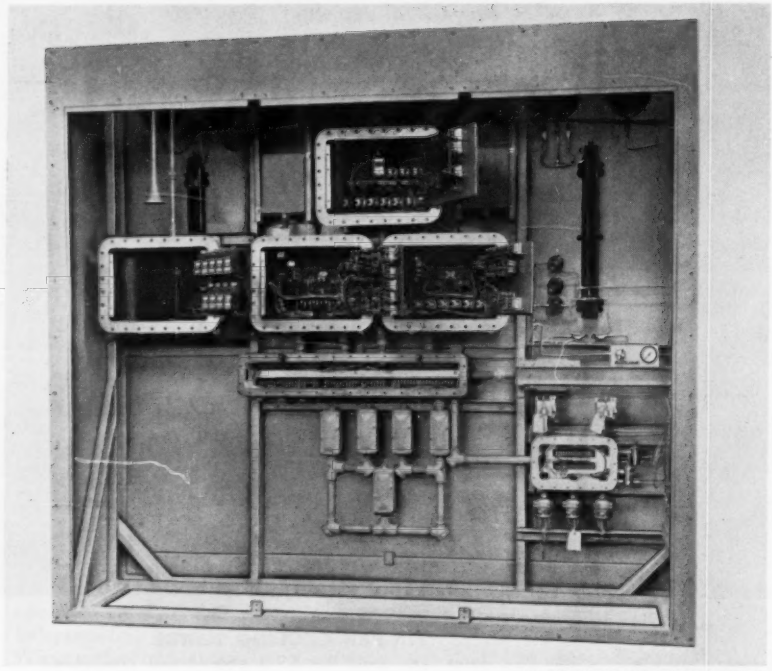
In addition to the automatically controlled KVG unit, the building contains six older horizontal 850-hp compressors.

ute of running unloaded at low speed, the fuel gas supply and ignition are shut off and corresponding green lights on the panel go out. Then the discharge valve closes and the blowdown valve opens. Finally, approximately 10 minutes later, the auxiliary equipment shuts down, and a green indicating light on the panel goes out.

Devices are located in the system to report on and indicate any of the following conditions: low lubricating-oil pressure; high lubricating-oil temperature; low jacket-water pressure; high jacket-water temperature; high discharge-gas pressure; low instrument-air pressure; low fuel-gas pressure. If, while the machine is operating, there arises any of the aforementioned abnormal or undesirable operating conditions that might prove damaging, the monitoring system will reveal it.

Should any of these conditions exist, a corresponding amber light will be turned on, and a horn will sound. The horn may be silenced by pushing a button and steps then taken to correct the cause of the alarm. Should another abnormal condition occur, a second amber light will come on and the horn will sound again.

Any of the following abnormal con-



PHOTO, VIKING INSTRUMENTS, INC.

BACK OF INSTRUMENT PANEL

The delay relays are of the 3-pole, 4-throw variety and are housed in explosion-proof boxes on which the covers are secured by up to 30 bolts. They are shown open here. All electrical instrumentation wiring was put on the engine-compressor in the shop where it was built. All the lines are led into one small box and from there to the panel.

ditions will result in an emergency shutdown: low lubricating-oil pressure; low jacket-water pressure; high jacket-water temperature; high discharge-gas pressure; engine overspeed. Should any of these conditions exist, a corresponding red panel light will be turned on and the horn will sound. Also, the ignition and fuel supply will be shut off, thus stopping the engine. The hydraulically operated valves will be repositioned, as in a normal shutdown, and auxiliary equipment will run for 10 minutes before shutting down. The horn may be silenced by pushing the proper button, but before the engine can be restarted, the cause of the shutdown must be corrected.

If it is desired at any time to operate the engine-compressor manually instead of automatically, this can be done readily by first ungrounding the magneto and purging and pressurizing the compressor by manually operating the hydraulic valves or, if power is available at the panel, by the use of manual switches. The engine can then be started by following the usual procedure described in the manufacturer's instruction book.

The Type KVG compressor was designed to meet station operating conditions of 550-psig intake and 800-psig discharge pressures. The piping is custom designed for this installation and includes pulsation-dampening equipment in the 10-inch discharge piping as well as in the 12-inch intake lead line.

The water that cools the engine and compressor cylinders circulates in a closed circuit. From the machine it goes to a Fin-Fan cooler outside the station and then returns. Two 4-bladed fans, each driven by a 7½-hp motor, supply cooling air in the tower. The water is circulated by an Ingersoll-Rand Motorpump rated at 623 gpm against 53 feet of head. The Hooper station water supply comes from two wells that are located on the property. It is pumped from them to a tower and then distributed by gravity.

The auxiliary lubricating oil pump is a Motorpump rated at 50 gpm against 53 feet of head and driven by an electric explosion-proof motor. The compressor cylinder oil is handled by a force-feed system put on at the factory as standard equipment. Engine lubricating oil is handled by two bypass-type filters in series—the first one containing Fuller's earth and the second using paper disk throw-away-type cartridges.

Starting air, at 250-psig pressure, is taken from a station distribution system that serves all of its gas compressors. To insure that the supply will not be interrupted, any one of three small I-R compressors can be drawn upon to furnish this air. One is a Class ES-2 straightline, horizontal, water-cooled machine driven by a 30-hp motor. The two others are Type 30 air-cooled units—one driven by a motor and the other by an internal combustion engine that can operate on either natural gas or gasoline. Air taken from the plant system is reduced to 100-psig pressure for operating pneumatic tools and other equipment used in maintenance work on the gas compressors and around the station. It is also supplied to the engine control panels at 70-psig pressure for operating instruments. The air-controlled governor receives its supply at a variable pressure of from 5 to 20 psig, according to the speed desired by the operator or the gas dispatcher.

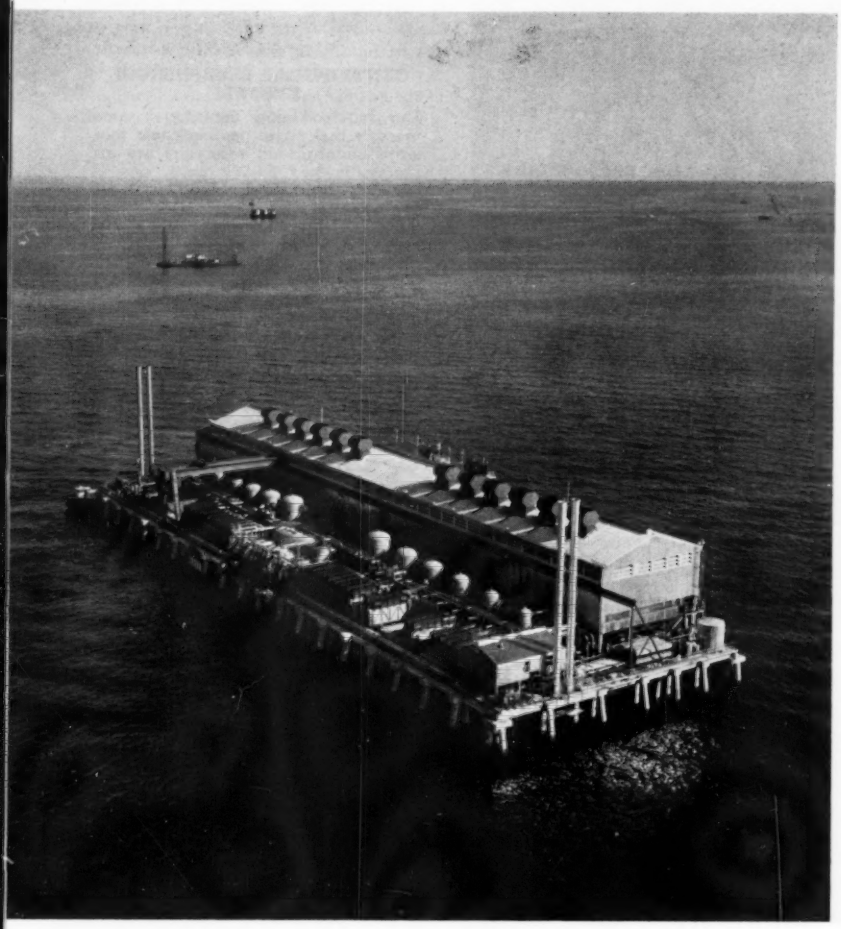
The panel includes means for checking the functioning of the pilot, warning and emergency circuit lights. At any time, whether the engine is running or not, all pilot lights except the five green sequence lights that are normally on, can be checked by pushing a "Light Test" button. Any light that then fails to show is burned out. Similarly, the warning and emergency circuits can be tested by pushing buttons under each light.

The lead wires that carry electrical energy to engine signal devices are all brought to a common explosion-proof junction box on the engine base. All leads are marked to correspond with those on the terminal block inside.

Northern Natural Gas Company gets its gas from fields in Texas, New Mexico, Oklahoma and Kansas. The transmission system has a capacity of 1.24 billion cubic feet of gas daily, and sales in 1957 exceeded 389 billion cubic feet. The main line runs from northern Texas to the twin cities of Minneapolis and St. Paul, Minn. A branch or loop line that takes off near Lincoln, Neb., and runs northeastward to Sioux City, Iowa, also then goes to Minneapolis-St. Paul, thus providing a supplementary artery to serve that area. From Sioux City, on this loop, a spur line extends northward to Sioux Falls, S. D., and thence northwestward to Aberdeen, S. D. It was built in 1956 to serve Aberdeen and 27 other South Dakota communities.

The Hooper station is on the loop line, north of Lincoln and about 50 miles northwest of Omaha, Neb., where the company headquarters are located. During the summer, when the demand for gas is relatively low, this branch carries much less gas than it does in the winter, and the Hooper station accordingly operates on a reduced schedule. Conversely, as the weather gets colder each autumn and winter, more and more of the station's capacity is normally put into service to meet the demand for gas in the service areas beyond it.

The Hooper station was built in 1942. It originally contained six horizontal compressors rated at 850 hp each. The first Type KVG was installed in 1956 and the second one in 1957.



AERIAL VIEW
This photograph shows Tia Juana No. 2. The supporting piles, the corrugated aluminum building and a portion of the gas-handling apparatus can be seen. Pairs of tall pipes at the ends of the platform release waste gas to atmosphere.

Creole's No. 2 Gas Plant Is Largest—

INJECTION PROGRAM CONTINUES

G. R. Smith

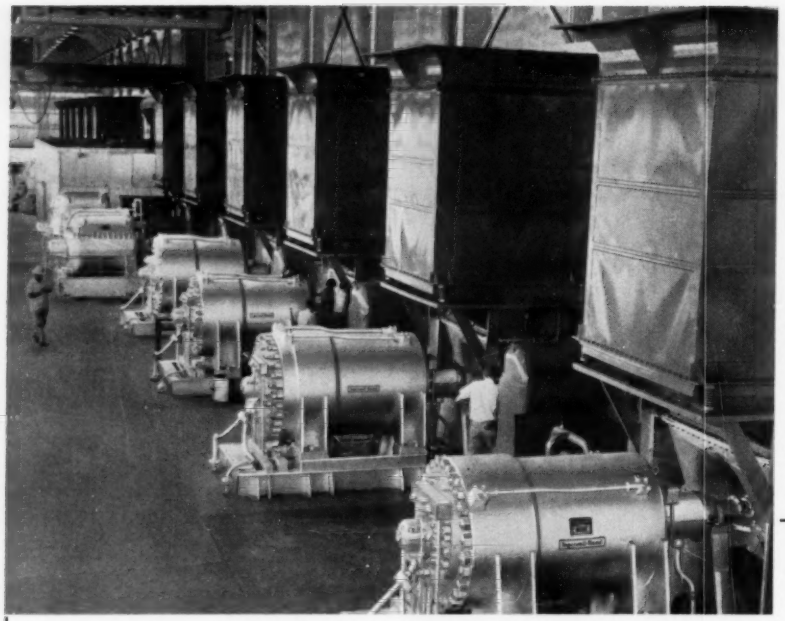
PRECIOUS natural gas produced in Creole Petroleum Corporation's oil formations hidden under Venezuela's vast Lake Maracaibo has a good chance of being put to the service of man. Creole is well underway with its continuing program of conserving the elusive gas by pumping it under high pressure back into the oil-bearing strata below the lake's floor. The company expects to have spent $175 million on the program by 1960.

Its newest conservation plant is Tia Juana No. 2 located in the large Bolivar Coastal Field that spans much of the eastern area of the lake. This second station, largest of all Creole plants, rests on piles about 7 miles offshore. It is within sight of its smaller sister station, Tia Juana No. 1, 6 miles to the north. A third conservation plant is currently far advanced into the first of its two planned construction phases. When its size is doubled sometime in the future, it will have the same capacity as No. 2.

These injection stations have several objectives. First, the injection method is an excellent manner for storing huge quantities of natural gas for future consumption, allowing it to be put to use as the demand occurs. Second, returning the gas under pressure increases the ultimate amount of oil that can be removed from the Eocene reservoirs. Maintenance of gas pressure in the oil strata some 4500 feet below helps in centralizing oil pools and driving the oil to the surface. It is estimated that No. 2, for example, will increase by one-third the amount of petroleum recovered from LL-453, the name of the area it serves. Third, oil well operation costs are lowered because the natural flow to the surface means expensive artificial recovery isn't necessary. The gas pressure increases the rate of oil recovery.

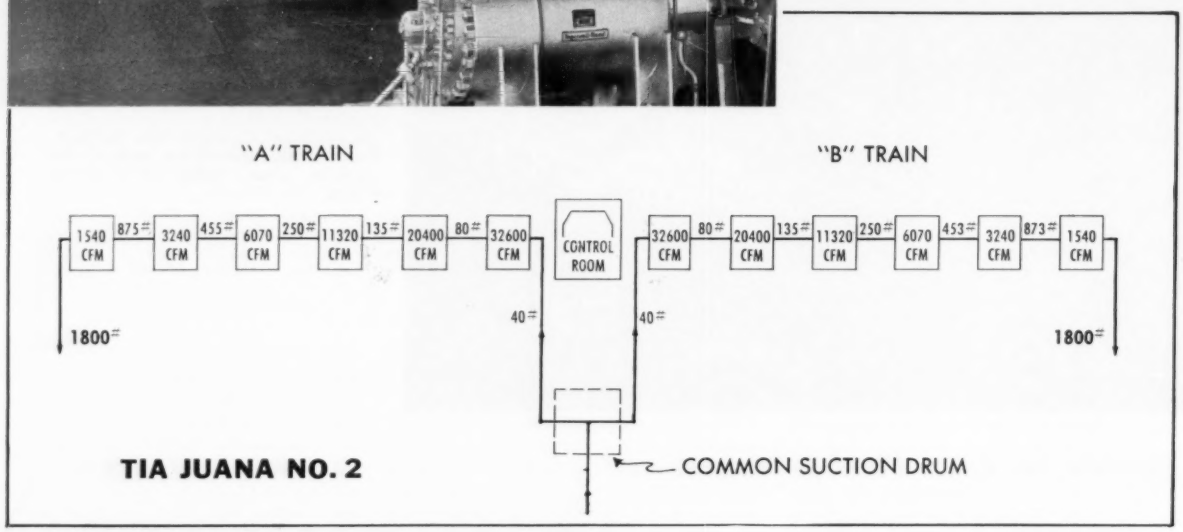
The geological area pressurized by Tia Juana No. 2, consists of truncated Eocene monoclines bounded by a Miocene-Eocene unconformity. There are lateral faults and a down-dip oil-water contact. The surface area of LL-453 comprises 9874 acres, and the oil-bearing sands' maximum thickness is 360 feet. The average thickness is 225 feet. The area was discovered in 1945, and between that time and the end of 1956, produced approximately 270 million barrels of oil.

Tia Juana No. 1, the first of Creole's



CENTRIFUGAL COMPRESSOR SYSTEM

The Ingersoll-Rand centrifugal compressors that pump gas back into four large underground reservoirs are arranged in two 6-bank units, one of which is shown here. Each set of six compressors works independently of the other, returning gas to its point of origin at about 1800-psig discharge pressure. The underground areas are well-suited for storing the valuable petroleum by-product for future use, and also allow a larger amount of oil to be recovered. The diagram shows the procession of gas through the two separate 6-stage systems of Tia Juana No. 2. Gas enters the common suction drum at 39-40-psig pressure and is split into the "A" and "B" trains. It is compressed to 78-80 psig in the first stage and passes up through the various pressures.



conservation plants, was begun in February 1953 and completed in September 1954. It was put into operation on a trial basis a month later, and has been operating at better than expected efficiency ever since. This plant, also located about 7 miles offshore, is designed to gather a daily 157 million cubic feet of gas and inject 137 million cubic feet per day. It utilizes ten, specially designed Ingersoll-Rand centrifugal compressors arranged in seven stages and driven by 6000-hp gas turbines. This $20 million installation was described in the February 1955 issue of COMPRESSED AIR MAGAZINE.

Tia Juana No. 2, where Creole applied much it learned with the designing and building of No. 1, is a more ambitious undertaking and is generally a larger version of its neighbor station. This plant and its attendant facilities cost approximately $28 million and can inject a maximum of 300 million cubic feet of gas each day into the four reservoirs that make up the LL-453 area. Construction of the plant began in September 1955, about 1 year after No. 1 began operating, and was finished in April 1957. As was done in the first plant, centrifugal compressors were selected because of the necessity of keeping vibration to a minimum as well as minimizing platform space required on the stilt-like foundation.

When chosen for No. 1, this type of compressor posed a special engineering problem: up to that time no centrifugal unit had been built for a pressure higher than 1000 psig. The pressure problem was solved with a special system of staging; as a result, the compressors at the first and second installations operate at about 2000- and 1800-psig discharge pressures, respectively.

Gas enters the injection system from flow stations where it first has been separated from the oil. Because the gas in the area is produced at a relatively low pressure, the intake pressure at No. 2 is only 39 psig. It enters a common suction drum and is passed forward into two independent groups of six machines. These two groups operate in parallel and contain six stages. In each group, the gas proceeds from 39-psig pressure, through 78-, 135-, 250-, 453-, 873-psig pressures, and finally emerges at about 1800 psig.

Power is supplied for the compressors by twelve large gas turbines, using the same fuel as is being compressed by the centrifugal units. These single-shaft drivers are rated at 8000 hp each, and together amass an impressive total of 96,000 hp. Tia Juana No. 2 is certainly one of the largest single concentrations of gas combustion turbines in the world, if not *the* largest.

Construction of the gas conservation installation began with the driving of 305 reinforced concrete piles into the lake bed. These stand in 85 feet of water. They are 200 feet long and were fabricated ashore in Creole's La Salina

industrial base before being moved to the site. The piles taper from 36x36 inches at the base, to 24x24 inches at the top that protrudes from water surface. The next step was construction of a platform 440 feet long and 131 feet wide on which to place a 2-story building for housing the installation's machinery. This building is a framework of steel covered with a sheath of corrugated aluminum. The turbines, centrifugal compressors, control room, machine shop, showers, change rooms and sanitary facilities are on the top floor of the building. On the lower floor, the scrubbers, coolers and other equipment are installed. Four cranes are provided for the station: one 40-ton and one 20-ton unit for heavy equipment, and two smaller cranes for moving material from launches and barges onto the loading platform. The 56x418-foot building includes an area of 23,408 square feet. In all, the construction of the station required 15,000 tons of steel—not far from being twice the 8530 tons that went into the construction of No. 1. Some 25,000 cubic yards of concrete, 5700 more than were poured for No. 1, are included in the larger plant.

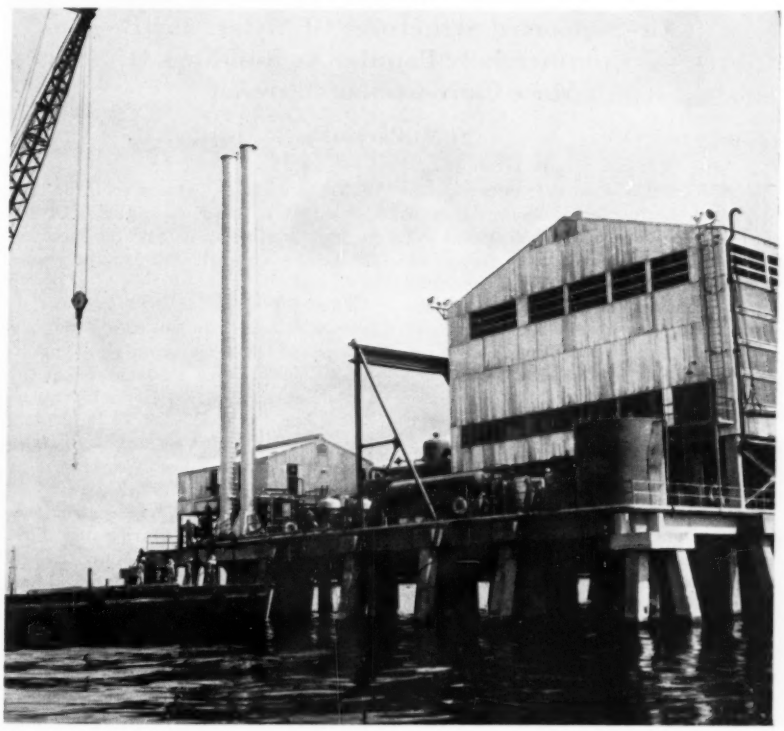
The gas-gathering system that feeds No. 2 connects twelve flow stations with a huge network consisting of 121,500 feet of pipe. Three sizes of inlet pipe carry the gas to the compressor station: 16-, 24- and 30-inch diameters. When the gas leaves the station, it travels through 10-inch pipe to the four reservoirs of LL-453 where the injection occurs. A total of 29,100 feet of pipe does the job here.

Because of the large diameters in the gathering-system lines, the pipes are buoyant and have a tendency to float unless ballast is added. Also, because the pressure of the water outside the inlet pipes is greater than the gas pressure inside, the lines must be especially tight. Both problems were overcome by first covering the pipe with a layer of asphalt, followed by a tight wrapping of fiber glass cloth. Then, heavy meshed wire was wrapped around the lines, and a 4½-inch concrete coating was applied for ballast.

Creole, which is an affiliate of the Standard Oil Company of New Jersey, is currently building a gas-gathering system that will tie together all the company's conservation facilities in Lake Maracaibo, including uncompleted Tia Juana No. 3 and a proposed Bachaquero installation. This system, to include 72,900 feet of huge 40-inch pipe, is thought to be the first to use so large a pipe in gas-gathering service or in 60-foot water depths. The new system will have eighteen separate lines with 43,400 feet of 30-inch and 10,153 feet of 16-inch pipe as well as the more than 13 miles of 40-inch line. This means a total of 126,453 feet in the new system.

30-INCH GAS LINE

Workmen fit a flotation tank to a 30-inch gas-gathering line prior to the line's launching into Lake Maracaibo. This large pipe, enclosed in asphalt, glass fiber and concrete for sealing and ballast, is part of the 121,500 feet of line that feed No. 2. A system of 72,900 feet of even larger 40-inch pipe, currently under construction, is thought to be the first time so large a carrier has been used for oil or natural gas, and the first time in 60-foot depths.



END VIEW

This picture shows Creole's No. 2 gas-injection station from one end of the platform. This area serves as a loading and unloading dock for the man-made "island," located 7 miles offshore in Lake Maracaibo. One of the lake's many watercraft (this one mounting a crane partially visible at left) is moored to the gas-conservation plant.

BULBOUS BUILDINGS

G. T. Schjeldahl Company Is Proving That Air-Supported Structures Of Mylar May Be As Commercially Popular As Buildings Of More Conventional Material

S. M. Parkhill

MYLAR is a plastic material with such an unusual combination of properties that it has stirred the imagination of many a man. Such an individual is G. T. Schjeldahl, president of the company in Northfield, Minn., that bears his name. As a result of pioneering experiments made by him and his associates, the firm became the first to produce an all-Mylar balloon. Using similar construction methods and materials, it is now manufacturing balloon-like commercial buildings.

Mylar itself has been on the market for some time. In recent years, however, E. I. du Pont de Nemours & Company's Film Division has been able to produce a weather-resistant variety and make it available for developmental work. It has been only within this year that the film has been obtainable in sufficient quantities to fulfill commercial demands.

Among the many changes made in the original plastic has been a chemical modification that gives Mylar a resistance to sunlight. Based on accelerated exposure tests, Du Pont estimates that a 0.005-inch-thick film will last 5 years. It has succeeded, too, in preserving the synthetic's original tensile strength of about 25,000 pounds per square inch, or that equivalent to hard aluminum. Of the plastics available, it has the greatest strength, even in the lightweight gauges of ¼ mil.

These facts, combined with such characteristics as a temperature resistance that spans the range from about minus 70° to 300°F, have made practical the experiments conducted by Birdair Structures, Inc., and the G. T. Schjeldahl Company with such pneumatically supported buildings as radomes, swimming arenas and temporary offices.

The idea of air-supported structures is not new. It was during the First World War that a Londoner named Lanchester devised an inflated dome, made of cloth and anchored with sand, suitable for field hospitals. Nothing was done with his models. The year 1934 saw John H. MacMillan, Jr.'s attempt at a grain elevator; and 1942, Herbert S. Stevens' proposal to erect buildings with roofs of 0.05-inch-thick flat metal sheet, which upon completion were to be distended by air pressure until they were dome shaped. Patents were granted, but nothing successful appeared until the fall of 1948 when the first radome was inflated at Buffalo, N. Y., after 2 years of planning.

Cornell Aeronautical Laboratory (CAL) manufactured the first radome to house large ground radar units. It was designed by Walter W. Bird and fabricated from neoprene-coated Fiberglas. Inflated, it reached a 36-foot height and a diameter, at its greatest section, of 54 feet. The dome was anchored to a 50-foot-diameter base and remained intact without a framework of any kind.

At the time the first radome was inflated, useful information on aerodynamic loading was practically nonexistant. Although experiments were conducted on small, solid models of similar shape, and structures built to a 1-to-24 scale were subjected to limited wind tunnel tests, it was not until the actual radome was inflated and proved successful that theories could be checked and design data formulated for future work.

Engineers had to consider more than impact pressure and normal winds. High negative pressures develop from the pulling out, instead of the pushing in, of the envelope. They reach their maximum in a plane that lies approximately 90 degrees to that of the wind direction. Together with inflation pressure, the result is a wide load variation acting upon the Mylar surface.

A spherical shape was devised since it would resist variations by distortion and redistribution of the load. When wind pressure is excessive, the shape is distorted, thus changing the air flow across the surface. Consequently, the aerodynamic loading is altered. This could produce excessive stress concentration, however since a flexible spherical shape is

LUTSEN RESORT

On the North Shore of Lake Superior in Minnesota, the air-supported dome, illustrated at the left, allows winter guests the pleasure of seemingly swimming out of doors. It appears opaque because of water condensation on its cold Mylar skin. Although the temperature outside dropped to many degrees below zero last winter, the guests swam in a 75-78°F temperature.

used, the units readily redistribute loads with a minimum of distortion. (The amount of distortion in such air buildings is dependent upon shape, loading, materials used and general design.)

Although the success of the CAL radome demonstrated the possibility of fabricating similar structures for industrial warehouses and the like, work continued primarily for the military. Since CAL was working under contract with the government, it was not in a position to independently sponsor commercial development, although lecture and technical-article inquiries were made to determine the market for such structures, should they become available. Bird and his associates formed, in 1955, a separate corporation in Buffalo called Birdair Structures, Inc., to investigate further the commercial aspects of air structures.

It was in June of the same year that the G. T. Schjeldahl Company was formed. In its past 3-year history, it has become one of the prime manufacturers of polyethylene bag-making machines, has developed a Mylar tape that is being turned out in ever increasing quantities, and has constructed some 1000 polyester Mylar balloons—one of which holds a world's altitude record of 143,000 feet.

When this record was made, Schjeldahl, better known to his more than 50 employees as "Shelly," made the statement that now, since the company had achieved the height record, it would aim to do the same in business. Its sales picture indicates that his goal is being achieved. The first year's total sales were doubled during the second year when they reached the $250,000 mark, and that figure was topped in 1957 with a total sales record of $658,000. Sales for 1958, it is estimated, will surpass the $1,000,000 mark. Gross profits increased from $71,000, or 25 percent of the net sales, in 1956, to $207,000, or 31 percent of net sales, in 1957.

The company is composed of three divisions. Mainstay of the operation is the Mechanical Division that produces balloon fittings and accessories. Its principal product is the polyethylene bag-making machine—a versatile and intricate mechanism that turns out transparent bags ranging in size from 2½ to 40 inches square at speeds of from 120 to 55 per minute. They are of the type, found in supermarkets, that contain candy, vegetables, meats, poultry and the like.

Packaging problems bothered Shelly while he was working as a research chemist for Armour & Company some 13 years ago. During the course of his investigations, he discovered that he could simultaneously cut and seal polyethylene with a hot knife. This became not only the fundamental principle of the company's side-welding machine, but the impetus for the business that was to follow.

SMALL BLOWER

This blower, being assembled at Lutsen Resort, is driven by a ¾-hp General Electric motor. It supplies air at a pressure of 2¾ pounds per square foot to keep the structure taut, even under high wind velocity. This building is of a shape similar to those used by industry for warehousing.

Under the name of Herb-Shelly, Inc.,

PRELIMINARY STEPS

In the illustration above, a worker is unrolling a spool of Mylar. This is spread (left) over the entire area and anchored before inflation. Although it weighs but 160 pounds, it has a tensile strength of 25,000 pounds per square inch and will not easily tear. When inflated, the structure rises to a height of 18 feet. At the left, a worker is spreading the 0.005-inch-thick film.

Schjeldahl organized a small-scale manufacturing operation in July 1948 that continued independently until 1954, when it was acquired by Brown & Bigelow of St. Paul, Minn., as a subsidiary. Shelly continued as its president until early the following year, when he severed all connections and formed the present independent organization.

The Tape & Special Fabrications Division, located in Northfield with the Mechanical Division, produces what is known as "GT" tape. This often has Mylar backing, and when applied to Mylar sheeting that has been cut to form balloons or air domes, the tape has a strength equal to that of the Mylar itself. Before heating, the tape appears as a milky white substance, dry and smooth to the touch. When a temperature of 350°F is applied, as is required for sealing, it becomes clear. So versatile is the adhesive that it reportedly can be used to join almost any two materials in a hermetic seal with a high dielectric strength over a wide temperature range and an effective life of 20 or more years.

The third facility of the Northfield company is the Balloon Division where the Mylar film is combined with "GT" tape to build super-strength balloons. The most recent large-scale venture here is the construction of commercial air domes, many having been made to date. One is used as an office and display center by The Eide Company, a real estate agency that is handling space for Office City, an area just west of Minneapolis, Minn. Another covers a swimming pool at a resort in Lutsen, Minn., and is of an elongated shape popular for industrial warehouses. Others, although not described in detail in this article, are similar to the second. One of these was made as a storage unit for Du Pont and is illustrated below.

STORAGE BUILDING

G. T. Schjeldahl Company built this unit for Du Pont. A blower, driven by a D. W. Ohan fractional-horsepower electric motor, supplies air at a pressure of 7½ pounds per square foot. It is said that the dome can withstand 70-mph winds. Above, is its typical "air" door.

OFFICE CITY

At night, with its dome illuminated by a blue light, Office City's leasing office looks much like a home of the future. The area at the left is the air-lock chamber. It is about 20 feet long and leads to a stairway that rises to the office portion directly beneath the dome. In the center of the structure, hanging from the crown, a piece of metallic Mylar that is rotated to reflect direct sun rays can be seen. Immediately below the office, air- and heat-supply units are housed.

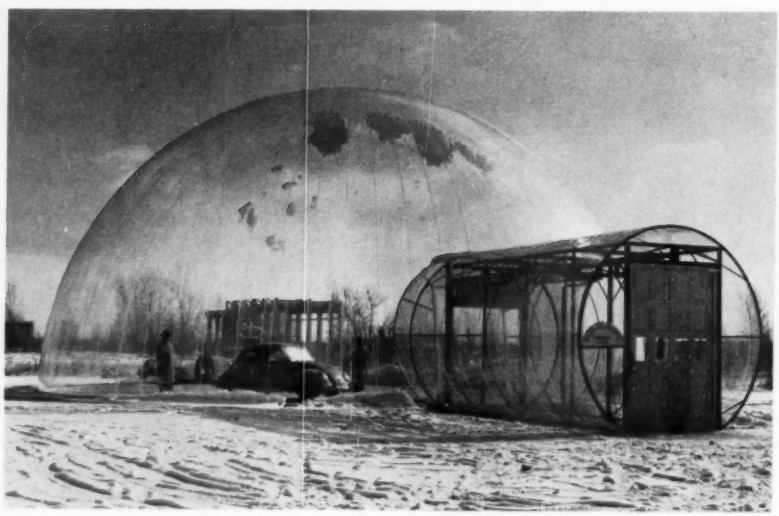
Office City, commonly called "a city at city's edge," will give future businesses 275,000 square feet of office space, parking service for 1500 cars and 30,000 square feet of such accessory accommodations as an auditorium, a health studio, restaurants, a gas station, a drug store, cleaners, barber and beauty shops, clothing stores and even a swimming pool. Construction is scheduled to begin on September 1.

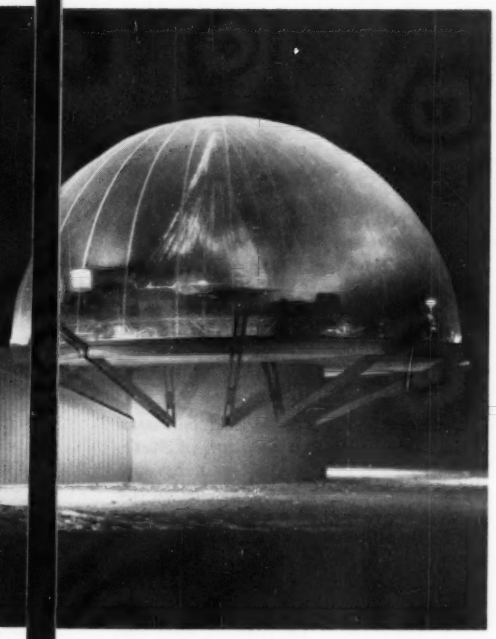
The Eide Company's temporary office consists of three distinct portions. The lower two sections are an air lock entrance to the upper dome, and a furnace and blower room; the third is above the furnace area and is the Schjeldome itself. As a precaution against letting excessive air escape from the inflated section, two doors are used in the first portion. They are about 20 feet apart and cannot be opened at the same time. The furnace room contains not only a heating unit, but an attached 720-cfm blower. Power is furnished by a ¾-hp General Electric motor. The furnace is rated at 210,000 Btu and keeps the 706-square-foot office space above heated for about $400 annually. Although the temperature dropped many times to a minus 4°F during the last winter, 78°F was maintained inside.

The Schjeldome is 15 feet high and has a diameter of 30 feet at the base. Deflated, the Mylar weighs but 85 pounds. It is inflated by dry air, furnished to the office area through a duct in the floor. Only 2¾-pound-per-square-foot pressure is needed to keep the building taut. On excessively windy days, the pressure is increased slightly by closing the return-air damper on the furnace. It is reported that no damage will be incurred, even when winds reach 74 mph.

The bubble is fabricated of tapered panels of Mylar, sealed with "GT" tape and meeting at the top with a crown piece. Attached to the crown is a metallic sheet of the same plastic that can be rotated 360 degrees. It is translucent and used to reflect the direct glare of the sun away from the workers inside.

The dome is attached to the building by means of a ½-inch cable draw-string arrangement that is passed through a





sleeve, or hem, formed by folding back the bottom portion of the dome a distance of about 12 inches. This is drawn tight against a 2-inch pipe that was previously bolted, through a piece of sponge rubber, to the floor. (It has been learned through experience that two pipes, instead of one, yield a better fit.)

Construction of the entire building took but 6 days, ½ day being devoted to the bubble. The floor is concrete, covered with tile, and is spacious enough to accommodate a layout table, three desks and fifteen chairs. So fantastic is the building, especially at night when the dome is illuminated with a blue color, that on the first evening after its construction, 1000 people visited the site. Since then, there has been an average of 25 to 30 sightseers each day.

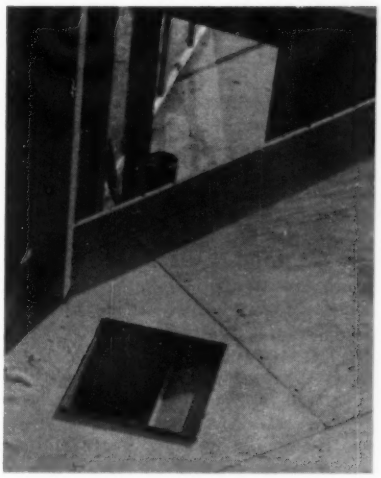
Located on the North Shore of Lake Superior, the Lutsen Resort allows its guests winter privileges of skating, skiing and swimming out of doors. The last sounds impossible, but because of a 0.005-inch-thick plastic Mylar Schjeldome over the pool, it is seemingly true to the bathers—to the human eye, the material is transparent. However, it is opaque to the long infrared rays and the complete spectrum of ultra-violet rays.

Deflated, the dome weighs 160 pounds, yet when inflated with a pressure of 2¾ pounds per square foot, it covers an area of 36x72 feet and rises to a height of 18 feet. The material has a tensile strength of 25,000 pounds per square inch and is connected by a 20x45-foot heated hallway to the ski lodge. This passage acts as a double-door air lock of the type previously described. Air is supplied by a blower driven by a ¾-hp General Electric motor.

The temperature at pool side remains in the 75°-78°F range, even though outside it may drop to a minus 15°F. Solar rays help in heating, as does the temperature of the water; however, during the colder days of winter, additional portable heaters are required. Unlike her sister structure at Office City, the water makes it impossible to dehumidify the air. Consequently, moisture condenses on the cold skin of the dome.

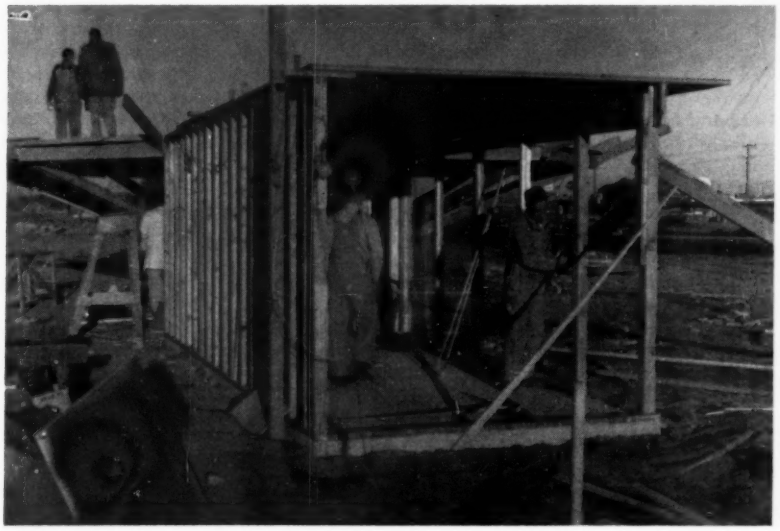
Although, a double-door air lock system was utilized in the two cases mentioned, Shelly states that a revolving door would be equally effective in helping to maintain air pressure. It should be pointed out, however, that the implication that if too much air were lost, the structure would instantly collapse, is not true. In the case of Office City, for example, it is estimated that it would be more than an hour before the building would be completely deflated. In the case of large arenas, or similar structures built under rigid building codes, it is recommended that a light framework be constructed inside to support the building in the event that the air supply should be stopped. The reason for the framework is psychological; if the structure were not there, panic might ensue.

These are but two shapes of Schjeldomes that could be used in industry. Others may become available as research, both in structural design and plastic, is continued.



ENTRANCES

The photograph reproduced above was taken during construction at the Office City site. At the top is a view of the stairwell as it opens into the work area, and the square opening in the foreground is the heat and air vent. Air is passed through this at 720 cfm, maintaining a constant 2¾-pound-per-square-foot pressure. Should the air supply fail, it is estimated that it would take about 1 hour before the structure would completely collapse.



CONSTRUCTION SCENES

At Office City, a workman is preparing to lay a strip of sponge rubber around the base of the dome. Through this will be bolted a 2-inch pipe and, by means of a draw-string arrangement, the dome will be anchored to it before inflation. The photograph at the left shows one side of the 20-foot air lock.

Something About An Eagle

FOR ANYONE with a dollar bill in his pocket, the bald eagle is a familiar sight; for bird watchers, the Haliaeetus leucocephalus is not. The white-headed eagle was once a common bird of prey found throughout the temperate and warmer regions of North America. Uncontrolled slaughter, destruction of nesting places and breaking of unhatched eggs have left few today. It was not until 1940 that a Federal law was passed in the United States giving protection to this symbol of American ideals. According to the legislation, a $500 fine will be levied on anyone harming the eagle—quite the reverse of days past when every bird was living with a price on its head. Today, the birds find refuge in such national preserves as the Everglades National Park, Florida.

For many years, little was known of this bird with the pure white head. (The term *bald* was applied, not in the sense of being naked, but in its original meaning, *white*.) Now it is believed that the bird lives for nearly 100 years, and that it mates for life. After about a 35-day incubation period, the eaglet is born. After another 10 to 13 weeks, it flies. For the first 1 to 2 years, the eagle is of smoke-gray color; not until it is 3 to 4 years old are the distinctive markings evident. The full-grown male is some 35 inches long, weighs about 8 pounds and has a 7-foot wing spread. The female is somewhat larger, weighing 12 pounds.

As all crossword puzzle enthusiasts know, eyrie is the name given to an eagle's nest. Eyries are usually found in the tops of tall trees, near water, for this bird preys upon fish, as well as small mammals, reptiles and birds. The nests are huge, often being 5 to 8 feet wide at the top, and are permanent, the birds returning to them annually. Westward-moving pioneers often used them as landmarks.

The eagle as a symbol of national prestige has a long history dating from pre-Christian Persia. It was used on coins, seals, flags and standards throughout the Mediterranean area and gained its greatest prestige in Rome. As the Roman Empire spread, the symbolism of the eagle was carried throughout Europe.

According to Roman tradition, the eagle, or aquila, was a symbol of royalty and military power. During times of peace, the eagle standard was kept in the Aerarium; in camp, it was placed in a small chapel. Soldiers honored it as a religious device, and the standard bearing it was carried in the first century of the first cohort on the rightmost flank. From the time of Augustus, the eagle standard bore the names and numbers of the legions, and shortly thereafter, surmounted portraits of famed leaders.

In Medieval Europe, the eagle replaced the lion as being the favorite device on shields. Prussia, Austria and Germany adapted the bird, not only as national symbols, but as medals of honor. The most famous of these is the Black Eagle, a Prussian order established by Frederick I in 1701.

It was natural that the members of the United States Continental Congress of 1776, being of European heritage, chose the eagle as a national symbol rather than the wild turkey, as suggested by Benjamin Franklin. Sir John Prestwick, a noted English antiquarian and friend of the colonies, suggested a design incorporating an eagle for the official seal of the United States. Quite a similar one was proposed by William Barton. The principal difference between the two lay in the fact that Sir John, schooled in aristocratic heraldry, placed thirteen stars upon the shield. Will Barton, being of the new country and of pioneer spirit, placed the stars above the shield in a more natural position. The Barton design was accepted, and a seal, 3 inches in diameter, was fashioned. In noting the events of the Congress, Charles Thomson, its secretary, specified that the eagle be of the bald, or white-headed variety. The first Great Seal was used on September 16, 1782, on a document granting General Washington authority to consult with the British about prisoner exchange. The device was not declared official, however, until September 15, 1789, 7 years later.

Since its adoption, the Seal has been in the custody of the Secretary of State. It is used, not only on certain coins and paper currency, but as the device on the President's flag and on about 3000 State documents annually. Six dies have been officially cut of the obverse. Its details and design arrangement were slightly modified between the second cutting in 1841, and the third and fourth of 1884 and 1902. The original design was 2-sided, but a die of the reverse has never been cut or used as a seal. However, a centennial commemorative medal was struck in 1882 that contained both the obverse and reverse designs.

The symbolism of the Great Seal is as old as that of the eagle. On the obverse, the uppermost portion of the shield represents Congress and is executed in blue to signify vigilance, preservation and justice. It holds together the thirteen red and white stripes that represent the States of the original Union. The white bands stand for purity and innocence; the red, hardiness and valor.

The eagle symbolizes supreme authority and power, as well as strength and nobility. It holds olive branches with thirteen leaves and berries in its right talon to signify a preference for peace. Gripped in the left talon are thirteen arrows, feathered and pointed upward, to tell of the nation's preparedness to fight for its rights. Above the motto are the stars, representing the immensity of space and the omnipotence of Divine protection.

The reverse design is of a pyramid emblematic of strength and lasting unity.

Pyramids are built with care, as were the foundations of the colonies; this one is incomplete to indicate that the young nation would continue to grow. Above the structure is the eternal equilateral triangle of the Holy Trinity; and within it, the mystic eye of the Universal Creator. Upon the base stones is inscribed the date, 1776.

There is considerable confusion as to where the motto *E Pluribus Unum* was derived. Some believe it was taken from the title page of the first issue of the *Gentlemen's Magazine*, an English publication with wide circulation in the colonies. It first appeared in 1731. Others think that it was taken from Richard Steele's "Essay No. 148" that appeared in the August 20, 1711, issue of *The Spectator* and opened with the Latin phrase attributed to Horace: *Exempta juvat spiris e pluribus una*—Better one thorn plucked out than all remain. Others give credit to Virgil's poem *Moretum* and its phrase *Color est e pluribus unus*, even though the poem describes the making of a salad. The list of possible sources is long, and the original may never be known.

The bald eagle has been used for objects other than the Great Seal. In each case, it appeals directly to that for which the Government stands. For example, many advertising handbills of the mid-1800's used the device in various forms similar to the one on the previous page. It marked what might be considered the beginning of "Made in U.S.A.," for wherever the eagle symbol appeared, it meant America. Likenesses of American heroes appeared framed by eagles; recruiting handbills and posters, as well as ballots with such mottoes as "The Nation, one and inseparable," and "Constitution and Country" appeared.

Perhaps the best known use of the bald eagle has been on American coins, the first of which appeared on a copper cent struck in Massachusetts in 1776. New York coined a similar copper in 1787, but what may be the most famous of these New World coins was a $10 gold piece known as "The Eagle." It was first struck in 1795, weighed 258 grains and was 90-percent pure gold, giving it great value. "The Eagle" remained popular until 1934. All of these early pieces are collectors' items today and helped to establish the eagle as the national symbol.

This and That

Lowering The Cost Of Living

It is always pleasant to hear of means by which living costs are being reduced. One of the more unusual was described by the Canadian Press. It has reported that the expense of telling the people of Halifax, N. S., when to go to lunch has been reduced sharply. Since it was founded, Halifax has had a cannon that booms out over the city every noon. The cost of this tradition has become increasingly expensive. In 1951, Major W. C. Borrett was appointed honorary superintendent of the Federal Northern Affairs Department's Historic Sites Branch. He discovered that the noon boom was costing about $25 a day and that the most expensive item involved was the blank brass shell that was expended daily. The Major, scouting for a less expensive "shot," located a South African 24-pounder dating back to 1899. Then, Canadian Army ordnance men remodeled the piece by sealing off the breech and inserting the firing mechanism of a .303-calibre rifle. Now, a few minutes before noon, a member of the Canadian Corps of Commissionaires, the security guard at the Citadel, prepares the gun by tamping a 1-pound bag of black powder down the muzzle, inserts a blank .303 cartridge in the rifle breech, waits for 12:00 o'clock and pulls the lanyard. The old artillery piece booms, belches fire and smoke, and the town residents go to lunch—all for about $0.70 a day.

★ ★ ★

Alphabet's Illegible Letters

A study conducted for the W. A. Sheaffer Pen Company indicates that the five letters *t*, *r*, *a*, *d* and *e*, that coincidentally spell the word "trade," are costing businessmen millions of dollars per year. The reason is that these letters are those most often written illegibly. The survey was completed by Wesley E. Scott, director of commercial and distributive education for the School District of Philadelphia. He and two assistant handwriting experts learned that carelessness and haste are the two main causes for hard-to-read writing. They can make *t* look like *l* or *i*; *r* like *i*; *a* appear as *u* or *ci*; *d* like *cl*; and *e* like *i* or *l*. Also these letters are the ones that most often end as just plain hen scratchings. Scott is supervising remedial handwriting courses for more than 20,000 Philadelphia secondary school students. The course was initiated because retailers complained that illegible handwriting was eating into their profits.

Along this same line, the Handwriting Foundation, whose headquarters are in Washington, D. C., distributes a handwriting training manual—its purpose to act as a "guide to aid in the development of more legible handwriting." The booklet is intended primarily for office managers and other persons who are concerned with people who use handwriting in their jobs. It contains illustrated instructions on how the more commonly confused letters should be written, as well as a paragraph with all capital and small letters of the alphabet.

★ ★ ★

150th ASTE Chapter

South East Florida is the one-hundred-fiftieth chapter of the American Society of Tool Engineers, a group with a current membership of 40,000 throughout the United States, Canada and Australia. This newest chapter has added 130 members, representing missile, electronic, engine and accessory divisions of Florida's aircraft industry. ASTE is only 26 years old, but during its rapid growth, it has produced broad educational programs, technical publications and conferences, tool shows, research and a standardization program that have brought tool engineering from a nebulous art to a scientific concept.

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1902 Blue-Printing

Chambersburg Engineering Company has uncovered a letter to one of its customers while going through some old files on the subject of hammer foundations. The letter is addressed to Vulcan Steel Company of Aliquippa, Pa., and is dated December 10, 1902. It states, "We will mail the blueprints to you tomorrow, as we cannot get a print today on account of the darkness and rain." The firm wonders, "How many of us can remember when blueprint frames were a common sight outside the drafting room windows on a sunny day?"

★ ★ ★

Char To Burn In Steam Power Plant

Char is a relative of coke and is what remains of bituminous coal after many of the volatiles have been extracted. It's a lowgrade, hard-to-ignite fuel. In what is said to be a major advance in boiler design, Babcock & Wilcox has come up with a boiler suited to burn char. American Electric Power Company is installing a power station, using the new design, on the Ohio River near Captina, W. Va., and next to Pittsburgh Consolidation Coal Company's mine that will supply the char. The Ormet Corporation, a joint venture of Olin Mathieson Chemical Corporation and Revere Copper & Brass, Inc., will buy the power. Essentially the process will involve volatilization of coal at a

temperature of about 1000°F, after which the remaining solid matter, or char, is burned. The B&W furnace is essentially one of the "Cyclone" type and will burn either coal or char, or any proportion of the two. Some coal will be mixed with the char, at least when firing up, to help ignite it. The fact that makes the whole idea economical is that char is not a premium-priced fuel as is coke. Although volatiles are obtained from coking, the essential process is designed to produce a nonsmoking premium fuel for use in such applications as steel making. The charring process, on the other hand, leans to the most efficient possible extraction of volatile gases for their value, leaving the char as a lesser-value product. In a way, it amounts to the profitable extraction of $2 worth of chemicals from $1 worth of coal, and still being able to use what's left for fuel. Pittsburgh Consolidation foresees an eventual annual market for 3,000,000 tons of coal, as well as an opportunity to expand into the coal chemicals field. The firm is building a $25 million char-processing plant at the mine-power plant site.

★ ★ ★

Gas As Clue To Uranium

The presence of hydrogen sulphide gas can be a clue to the location of uranium ore concentrations, according to two scientists conducting research separately at points 2000 miles apart. An assistant professor at Yale University, Mead L. Jensen, learned that Eugene Grutt, who is a geologist at the Atomic Energy Commission's laboratory at Casper, Wyo., was also doing work on the use of the gas as a uranium locator. Jensen communicated with Grutt, and the two found their conclusions matched. The use of the hydrogen sulphide gas probably will speed the finding of the radioactive ore because the gas areas are already known. The link between the two materials began some 70 million to 200 million years ago, according to Jensen's theory, when sediments of the vast Colorado plateau were being deposited. Anaërobic bacteria, found in areas where little free oxygen exists, generated hydrogen sulphide gas as they fed on sulphate solutions in water-saturated silt and sands. The gas then moved to void spaces in the porous sandstones. Water, still present in some shale beds, had come in contact with uranium from volcanic ash. The water migrated through the sandstone and began reacting with the hydrogen sulphide. This produced sulphide minerals and, as the two scientists have learned, the precipitation of uranium oxide. The theory implies that when ancient organic matter is found along with anaërobic bacteria, there is a possibility for the existence of uranium. Jensen points out, however, that a lack of organic matter doesn't necessarily mean that uranium is not present, because the hydrogen sulphide gas may have migrated from its original area. A mass spectrometer is used to determine the sulphur isotopic variations; if the variations spread over a high and broad range, it's possible the sulphur in question came from hydrogen sulphide of organic formation.

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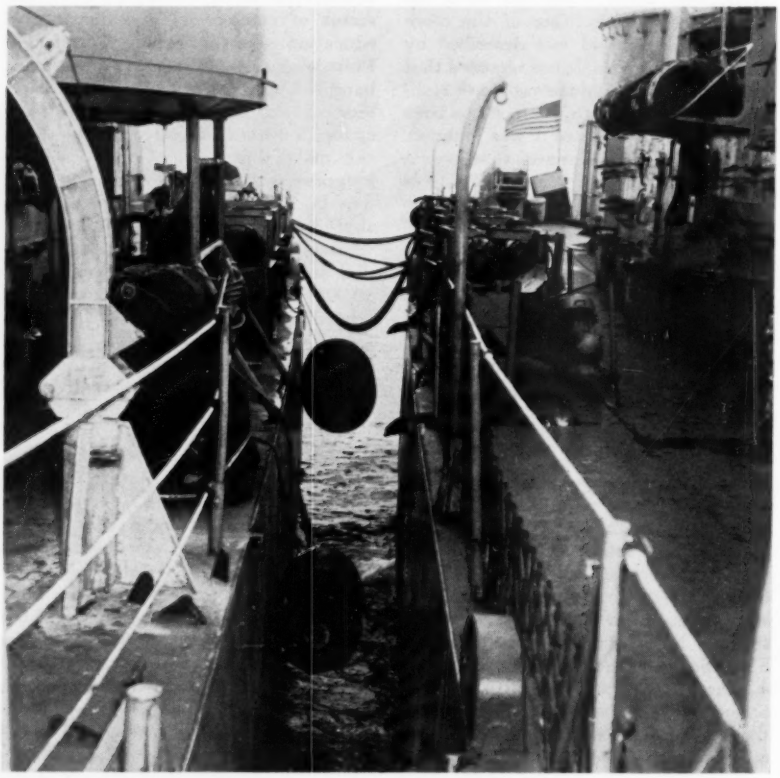
Vitel Joins Ranks of Resin Fibers

The Goodyear Tire & Rubber Company has announced that the firm is now building a $9,000,000 facility at Apple Grove, W. Va., for the production of Vitel, a new polyester resin for use in spinning man-made fibers. The product is an orientable, crystallizable, linear copolyester, and is one of a family of resins from which may stem a potentially unlimited variety of similar products. Actual spinning of the resin into a usable fiber will not be done by Goodyear, but by an independent fiber producer, Beaunit Mills, Inc. The latter firm has initiated construction of a $10 million plant to handle the Goodyear polyester resin. The facility is expected to have an annual capacity of 10 million pounds of fiber. The product is said to have all the characteristics that have stimulated the rapid acceptance of polyester fibers in recent years. It stems from Goodyear's research into fibers for improved tire cords—a project beginning in the early 1940's. Although Vitel, one of the polyesters resulting from this search, is not suited for tire cords, it will find many textile applications. Another resin of the same family was marketed by Goodyear in February and is known as Videne. A special film, it is used in laminating work. Videne TC is another form of the film that is used for machine packaging of meats and other foodstuffs.

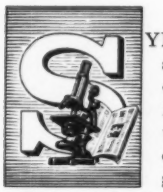


SHAPED LIKE A BARREL

Two U. S. Navy ships, nested together by fore and aft lines, are protected by giant air cushions manufactured by Goodyear Tire & Rubber Company. Formerly, rope fenders were used. After a delivery of this pneumatic variety to the "mothball" yard at Rhode Island, it was decided to try them in working fleet operations. The plan was successful, and as a corollary, it was determined that it was no longer necessary to send the ships to sea during storms to protect them from damage against docking areas. Built like premium grade passenger car tires, but with a carcass that is much wider and a steel bead that is smaller in diameter, these fenders have metal plates in the ends that are equipped with swivels so that the devices will roll with the ship and cushion it against shock. Oil companies engaged in off-shore drilling operations are testing the fenders as a means of cutting ship and rig damage during ship-to-shore supply operations.

EDITORIAL

Synergism



SYNERGISM is a word that seems to go against the laws of mathematics. Essentially, it means a condition under which two agents working cooperatively have an effect greater than the sum of the effects of the two taken independently. The word is most often applied to physiology, but, of late, has been used in connection with human coöperation.

The sciences used to be broken into a number of apparently independent subjects—chemistry, physics, geology, mathematics, etc., and still are taught as though they were distinct. Although the divisions seem to follow natural dividing lines, they are now recognized as being only arbitrary.

In early days, when man first began to observe natural happenings with an analytical eye, there were no such divisions. Aristotle did not confine himself to one classification, but was a master of all natural knowledge of his time. As the sum of human understanding grew, it became impossible for one man to fully grasp all phases of scientific learning; the barriers were erected.

METHODOLOGY of science is a well defined form. It has been described in many ways, one of the most graphic of which draws a comparison with a latticework. Facts make up the stringers and seemingly interrelated ones are assembled by a process of scientific deduction, intuition and observation of the results of experimentation. Frequently, the latticework is begun not at the bottom or top, but somewhere in the middle and later extended to a firm foundation on physical laws. Sometimes, of course, the web must be torn down as new facts come to light, or old ones are rearranged.

As these latticeworks have grown with the addition of new facts, certain areas are found where they transgress the arbitrary barriers: streams of knowledge, that once seemed to lead off in different directions, coalesce. At these joint frontiers of knowledge, it often turns out that striking advances are made. The methods and knowledge from one domain spill over into another—and like is returned—and it becomes apparent that the combination has produced a total greater than the sum of the two taken independently. It becomes possible to glimpse a 3-dimensional latticework encompassing all science, the many classes of study being seen as faces of a many faceted figure. There are, of course, a great many holes yet to be filled.

WORKING teams of specialists have come to be an accepted thing in this day. The stereotyped picture of a bearded researcher working alone in a cluttered laboratory, emerging only at intervals to announce world-shaking discoveries, is certainly no longer true, if indeed, it were ever that way. The trend is definitely toward more and more collaboration between scientific people in fields once thought to be widely divergent. Even the so-called social sciences are coming into the picture, lending to and receiving valuable aid from the physical or pure sciences.

COMMUNICATION is, perhaps, one of the most important elements of the idea of collaboration. Naturally, not all scientists can be assembled into one laboratory. Without communication of ideas by means other than the spoken word, the world would be hundreds of years behind in its technology. More and more technical schools are coming to recognize that part of the training they offer must include not only courses in how to find information, but how to present it most effectively in writing. Ideal communication between researchers working on the same subject is an absolute necessity if anything is to be accomplished. More often than not, however, collaboration between scientists is a very loose thing. Creative minds are extremely sensitive to ideas, thus a report of research may stimulate other scientists to a new course of study or present a possible solution to a problem in some other field.

Many advances in science that perhaps would have led toward the earlier development of better consumer and industrial products, it has been found, did not achieve quick recognition simply because they were not understood. Such cases illustrate yet another need, and that is for translators. Specialists in certain fields tend to build up extensive vocabularies going under the general heading of "terminology of the trade." While many of these special words are extremely graphic, some fall under the heading of "gobbledygook," a term referring to unnecessarily confusing words and phrases. Good communication is also necessary if ideas are to be sold to the men who control the purse strings.

THE PAST several decades have seen the remarkable growth of a vast number of trade and scientific journals on which a great deal of the burden of effective communications on broad and general planes now rests. These publications carry ideas and news of methods and products, of new advances in technology across the artificial barriers between fields, as well as relay data among the members of a specific group. Perhaps it is not too farfetched to say that the services performed by the trade press have lended to the type of synergism that has advanced science and technology so rapidly in recent years.

Bat Cave

BAT CAVE, a giant cavity located about 600 feet up the precipitous wall of Grand Canyon, Ariz., is now yielding a rich harvest of bat guano to New Pacific Coal & Oils Limited, of Toronto, Canada—the company that found a practical method of removing it from its almost inaccessible site. The cave, now leased by the firm from the U. S. Department of the Interior, was discovered in the early 1930's. However, it wasn't until recently that a lengthy aerial tramway was erected to haul the prehistoric material 1½ miles across the river's gorge, and up to the opposite edge.

The guano deposits are thought to amount to 100,000 tons and to be worth at least $10 million. The material is estimated by archeologists to have taken 60,000,000 years to accumulate. High in nitrogen content, it is an excellent fertilizer in its existing odorless, powder form. The guano also may have value as a source of drugs.

The process of moving the substance begins with its being picked up by vacuum and carried about 100 feet through a 10-inch pipe to a bagging station. There it is dropped into bins at a lower tramway terminal and is passed into a bucket. The tramway cable runs 9400 feet from the loading to the discharge terminal. Consolidated Western Steel, a division of United States Steel, built the structure, thought to be the longest single-span tramway in the world. Following the guano's removal, it is packaged in 5-, 10- and 25-pound containers, and stored in a warehouse at the top of the canyon. From there it is taken to Kingman, Ariz., about 60 miles away, for more permanent storage. After it travels by rail to Los Angeles, Calif., it is distributed nationally. The Canadian firm plans to limit withdrawal of the product to 10,000 tons per year, unless added deposits are found in the unexplored reaches of the cave.

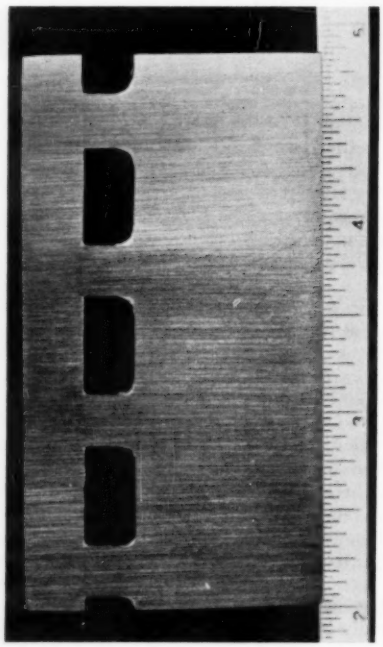
Earlier attempts at removing the guano were singularly unsuccessful. One plan to carry out the valuable material by barge was thwarted by the treacherous Colorado River. A later attempt made use of helicopters and airplanes, but this method proved too costly. Helicopters, however, did play an important role in the recent successful scheme. "Whirlybirds" strung 11,500 feet of ⅛-inch construction cable across the 2911-foot deep gorge so that a heavier 1¼-inch tramway track cable could be pulled into position.

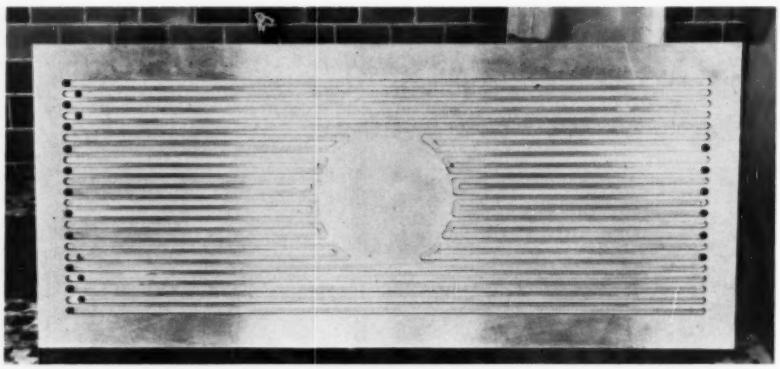
Bat Cave is the only known guano deposit in North America that is considered to be of commercial significance, and is the only one being operated at this time. The cave's constant temperature of about 70°F, and its negligible humidity have helped the guano retain its chemical properties, including from 10- to 16-percent nitrogen, with considerable phosphate and potash. None of the winged mammals that once inhabited the cave live there now.

CHANNELED HORTONCLAD

PRECISION

In the close-up (below) is a ground section of Channeled Hortonclad plate showing its ½x¼-inch channels. The careful control over the distance between heating or cooling media and plate surfaces, as well as precision of the milled channels, is easily seen.





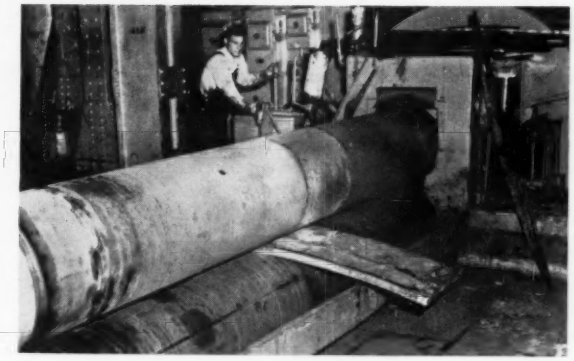
BEFORE CLADDING

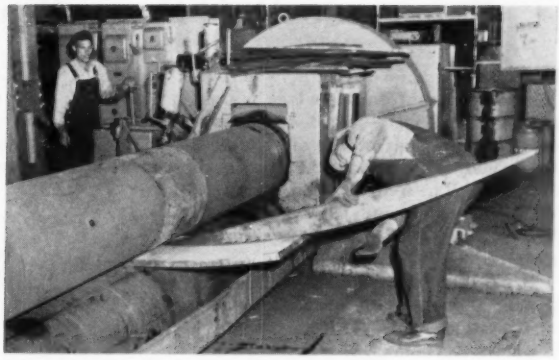
The illustration above is of a channeled steel plate for a hypersonic wind tunnel section before the cladding was applied. It is 21x48x1¼ inches in size and has eleven parallel loops for low pressure drop, high flow and temperature-distribution control. Notice the 22 inlet-outlet taps (appearing as dark spots) at the extremities of the loops. The central blank area will be bored later to accomodate instrumentation and control.

OPPORTUNITIES for using heavy composite plate as a heat transfer medium have emerged as the result of Chicago Bridge & Iron's method of vacuum cladding known as Hortonclad. A heavy base plate, generally of steel, is channeled before the alloy or nonferrous cladding layer is applied, to form coil-like passageways for a cooling or heating medium in the very heart of the finished clad plate, and at a selected distance from either surface. The new plate, with its integral internal coring, is aptly named Channeled Hortonclad.

As produced by CB&I at its Birmingham, Ala., plant, the plate has already been applied for precise surface temperature control in venturi sections of hypersonic wind tunnels and the heated platens of laminating presses. In reactors and vessels, it has provided internal heating, and cooling, of critical partitions.

Processing Channeled Hortonclad reportedly eliminates bulky surface coils and double-wall constructions, in many instances. In the metal-producing, metal-working and machinery fields, interest





TESTING THE BOND

One remarkable fact about Channeled Hortonclad is that test plates nearly 1½ inches thick have been rolled to a 12-foot radius in one direction, then to a 12-foot radius in the opposite direction, and finally back to flatness, without affecting the bond, the steel layers or the channels. These two illustrations show this operation and suggest a possible application in the construction of cylindrical structures and heavy code-welded vessels. The plate illustrated is 48 inches long. Radiographic and hydrostatic testing proved the plate wasn't affected.

centers about heavy chill plates for handling hot work and heated platens and forms for molding and assembly operations. Channel cross sections may vary in size. Depths have ranged from ¼ to 1 inch and widths from ½ to 1½ inches, depending on the thickness of the cladding.

Because they are internally channeled by a vacuum process, new metallurgical freedom in selecting base material and clad surface compositions has been realized. Dozens of cladding and base plate combinations have been successfully used in channeled plate, and many other types are being tested in the laboratory. According to CB&I, there appears to be little reason why all the materials available as solid clad plate cannot be used. These would include austenitic stainless steels; straight chromium stainlesses; and nonferrous materials such as nickel, Monel, Inconel, Hastelloys, silver, copper, cupro-nickel alloys, brass and the like. It has been reported, however, that the use of other, less common materials, such as titanium, zirconium, bronze and tantalum, is also foreseen.

At present, the most popular base materials are, of course, the low-carbon steels of firebox quality, although occasionally other base materials are used for specific properties, as in titanium-on-copper. Plastic laminating press platens have been made of air hardening 6-percent chromium alloy steel on mild steel, and many production plates, for wind tunnel and reactor work, constructed of 5/16-inch-thick 405 stainless on heavy mild steel, as well as 403 stainless on 403 stainless backing. Plates produced for field use so far have been up to 220 inches in length and have had widths that have been said to be as great as 60 inches.

The channeling for the cooling or heating fluid may follow almost any pattern. Layouts for large plates are often divided into independent coil-like, subsystems in order to give independent temperature regulation over different sections of the finished material, as at the edges and around the openings; and to reduce pressure drop of coolants and heating liquids by having several "coils" in parallel, rather than one, long labyrinth-type path. Connections are made to the channels inside the finished plate through drilled and tapped holes in the base material.

Fluid Transporter

A FLUID transporter with ten large baggy tires, each with a capacity of 500 gallons, has been developed for the U. S. Army Transportation Corps. The tires are towed by a powerful truck and are capable of moving liquid cargo over difficult terrain, ranging from snow-and-ice-covered areas to swamplands. The 5-foot-high tires, mounted in tandem, have their own axles, brakes, towing assemblies and filling and emptying systems. Each is 3½ feet wide.

The Four Wheel Drive Auto Company (FWD), which designed the 5000-gallon-capacity vehicle, along with the Goodyear Tire & Rubber Company, says that the tires can carry almost any liquid, including water, fuels and chemicals, thus presenting a wide variety of applications for the transporter. Though developed for the armed forces for transporting fuel for aircraft, missles and the like, the vehicle could also be applied to such nonmilitary applications as moving large quantities of water for forest-fire fighting or carrying liquid fertilizers.

Other liquid transporters of this type have been developed with tire capacities from 140 to 1000 gallons, and FWD reports that the main limiting factor is the pulling capacity of the towing vehicle. After the tires have reached their destination and have been emptied, they can be pulled away, filled either with air from atmosphere, or air under low pressure.

DOUBLE DOUGHNUTS

Looking like a row of treaded double doughnuts, the ten large tires of this fluid transporter developed for the U. S. Army Transportation Corps move over rough, bumpy ground. The tires hold 500 gallons each, and are being towed by a truck manufactured by Four Wheel Drive Auto Company. Similar units have tire capacities that are as great as 1000 gallons each.

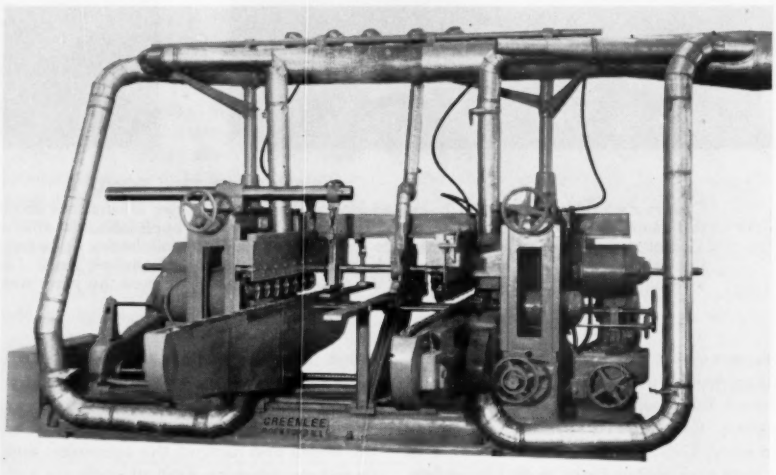
Pneumatic Hold-Down Beams Eliminate Feed Problems

IN THE manufacture of plywood, veneer is turned from large logs, clipped to eliminate defects, joined at the edge and cut into plies of a size somewhat longer and wider than the finished panels are to be. These layers are next spread with glue and laminated in large presses. When dry, the plywood is trimmed to size.

A machine for accurately sizing such panels, as well as for splitting them to make smaller sizes from the larger, is a double-end skinner saw manufactured by Greenlee Bros. & Company, Rockford, Ill. Plywood panels are fed through it by two continuous feed chains. The panels are held firmly to these powered chains by two series of rubber-covered rolls that are arranged in hold-down beams.

Feeding difficulties would often be experienced on a unit of this type because of the varying thicknesses of panels being fed through it. To eliminate such trouble, each rubber-covered roll is provided with an air cylinder in the hold-down beam above it. Thus, adequate pressure of each roll against the panels, regardless of variations in the thickness of the wood, is maintained throughout the operation.

The basic arrangement of the machine illustrated here is for either trimming both ends, or sizing both edges of plywood panels at a single pass. However, center splitting units can also be added where it is desired to use the machine in converting large panels to smaller ones. Then, panels can be divided either along their width or length during the same pass, at which time the outer edges are removed or trimmed.



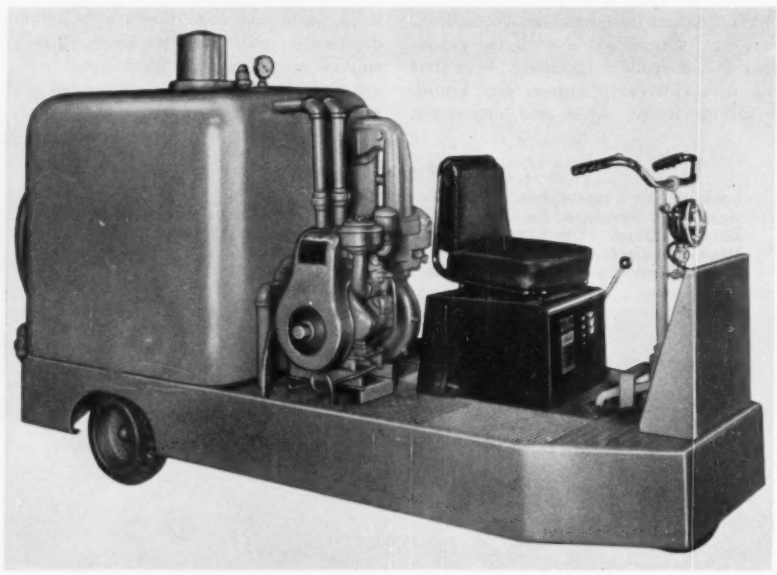
FEEDING AREA

A close-up view of the feeding area of a Greenlee double-end skinner saw. In operation, the panel proceeds through the machine, engaged by the rubber-covered-rollers, each of which is provided with an air cylinder in the hold-down beam above it.

Mobile Sump Cleaner Utilizes Vacuum And Air Pressure

SLUDGE-VAC is a machine that collects sludge, chips and waste oil from machine tool sumps and settling tanks, transports it to a disposal area and discharges it under pressure. It is said that it is capable of performing the operation in one-twentieth of the man-minutes required by hand-shoveling methods, permitting the man and tool to continue operation with the least amount of delay.

The device is driven by a 14.7-hp, 2-cylinder air-cooled engine and rides on puncture-proof tires for easy maneuverability. Measuring 42 inches in width, this nearly 10-foot-long vehicle can be easily driven through narrow machine-tool aisles.



Its vacuum generator is driven by a 7.5-hp gas engine with an electric starter, or by a 5-hp electric motor. It develops a suction of 32 feet of water, which is reportedly enough to raise the heaviest of sludge from pits 10 to 15 feet deep. The tank has a capacity of 200 gallons. A stainless steel float rises during the operation until the container is full, at which time it operates a valve to cut off the vacuum and to pressurize the tank. The unit then moves out to the disposal area and is unloaded under pressure. The discharge pressure is governed by an adjustable safety valve, blowing sludge and waste as much as 50 feet. Twenty-five feet of 1½-inch neoprene hose is coiled on a rack at the rear of the machine.

The unit was developed by Gorske Industrial Equipment Company of Indianapolis, Ind., and is said to be equally valuable in servicing drip-pans, lint traps, dust collectors, grease traps and filters.

Pneumatic Riveter Comes To The Aid Of Punch Press Operators

RIVETER DOES IT QUICKER

The two photographs above show how an Ohio company formerly marked punch press guide holes; the picture below illustrates the improved, 1-man air-riveter method. When done by hand, a slight mark was made, then a second man used a sledge on a larger punch to make the indentation. When an air riveter was selected to do the job, only one person was required, and the work was done much quicker.

An air-operated riveter, used to mark punch-press guide holes in steel for riveted girders, has reportedly saved an Ohio company more than $33 per girder. The firm formerly needed two men for the operation; now it does the job in less time with one man.

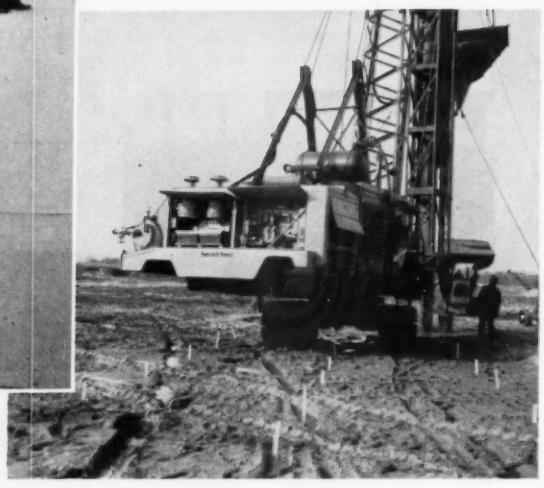
By previously used methods, a wooden template was placed on the steel plate. One man held a punch whose diameter was the same as the template holes. The second man used a light sledge on the punch to make a shallow hole. The indentation is necessary for guiding the punch press since, with larger plates, the press operator may be more than 6 feet from the mark and cannot see it. He must rely on the feel of the punch center dropping into the slight cavity.

The new method makes use of an Ingersoll-Rand Size AVC26 lightweight riveter with an offset handle and a special Jackset. The body of the Jackset is the same diameter as the template hole, and the tip is sharpened to a 90-degree point. The operator places the Jackset in the template hole and in less than a second marks a hole of 1/8- to 3/16-inch depth. With this speed, it takes the operator only 3 hours to completely mark a girder, while the previously used 2-man method consumed 6 hours. The cost of marking a girder is now approximately one-fourth the previous cost. In addition, operator fatigue is much less, and there is no danger of flying fragments from burred punch heads.

Breaking old asphalt with an I-R PB8A paving breaker operating off a 125-cfm Gyro-Flo. This compressor will handle two such breakers.

Driving a special-type pile driver as sand casings are placed for a bridge approach, this big 900-cfm Gyro-Flo replaced two smaller compressors.

GYRO-FLO *in the news*



On a pole setting job in rocky soil a utility company uses the highly portable 85-cfm Gyro-Flo and an Ingersoll-Rand PB6 paving breaker.

Emergency air power to a manufacturing plant is furnished by this 900-cfm Gyro-Flo, while the plant's stationary unit is being repaired.

Artifical snow system for the ski slope of an eastern state park is powered by these Ingersoll-Rand Gyro-Flo units . . . a 600-cfm and a 210-cfm.

A Gyro-Flo for every job...

the right compressor...from the most complete line of rotary portables available

To get maximum efficiency and economy on *any job* requiring air power, you need a compressor that's the right size for the tools you want to operate. With the Ingersoll-Rand line of rotary portables, you can match the compressor to the job . . . get full, efficient pressure at the tools, yet avoid excess horsepower and fuel costs. The I-R Gyro-Flo line is the world's most complete: six models, capacities of 85, 125, 210, 315, 600 and 900 cfm. Backed by a nation-wide service organization.

And regardless of which size you choose, your Gyro-Flo compressor will give you unmatched dependability and efficient performance on every kind of job. The exclusive Gyro-Flo rotary design, developed by Ingersoll-Rand, has been imitated but never equalled in overall economy of operation. Ask your I-R dealer or representative for details on the units best suited for your requirements.

Ingersoll-Rand

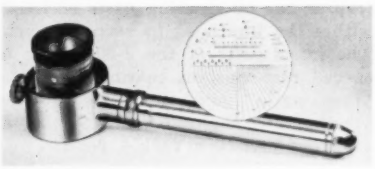
2-850

11 Broadway, New York 4, N.Y.

COMPRESSORS • ROCK DRILLS • AIR TOOLS • CARSET BITS • PUMPS

Industrial Notes

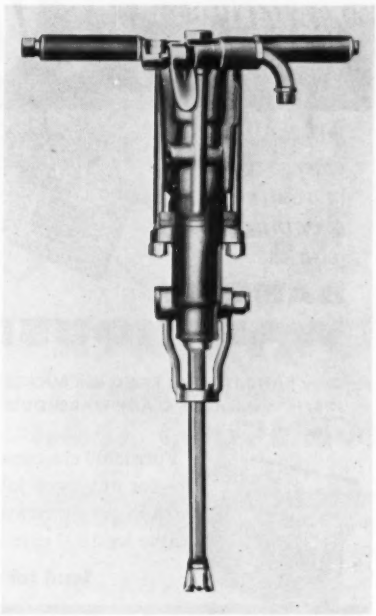
CHECKING of tiny parts and dimensions is possible with a 6-power pocket comparator. The unit has an etched glass reticle that gives linear dimensions in both inches and millimeters for measurement of diameters, radii and angles. When used without



the reticle, the comparator becomes a magnifier. An illuminator, that works on pen-light batteries, lights both the comparator reticle and the work to be examined. The comparator, it is said, may be removed from the illuminating section for easier carrying. *Edmund Scientific Company*, Barrington, N. J.

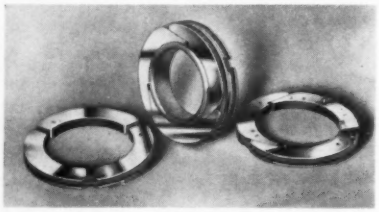
WAX-PLATE No. 6143 is the name of a low-viscosity coating developed by Johnson's Wax to protect manufactured metal parts against weather and handling. The product was formulated to safeguard metal surfaces during storage indoors and for shorter outdoor periods. It is not oily or greasy, but is said to be true wax, that not only gives protection but lubrication as well. Application can be made on metal springs, machined parts, hand tools, and metal and chromed parts of vehicles and appliances, and the like, by dipping, rolling, brushing or spraying. Removal is possible by merely wiping the coated object with hydrocarbon solvents. The substance has a flash point above 100°F, and the film it develops dries in 20 to 30 minutes at room temperature. It has a nonvolatile content of 15.5 percent, and is available in 5- and 55-gallon containers. *S. C. Johnson & Son, Inc.*, 1525 Howe, Racine, Wis.

CONSTRUCTION, maintenance and mining work are uses for a lightweight rock drill called the J-30A Jackhamer, introduced by Ingersoll-Rand. The manufacturer reports that the unit is ideal for applications where a powerful, but easily handled, drill is needed. Its blower valve is incorporated into the throttle valve for operating ease and convenience. By turning the throttle valve to its rearmost position, the operator directs air under full line pressure through the drill rod and bit. This is said to instantly clean the hole of all cuttings. The unit's backhead design



is said to permit easy conversion from the standard blower operation to plain dry or wet styles. Because nearly all working parts of the drill are interchangeable with those of the earlier J-30, the new model can be added to existing Jackhamer lines without increasing parts inventories or storage space. Further, the manufacturer states the improved J-30A is offered at no increase in cost over the J-30 model. A new drill centralizer has all working parts enclosed within the fronthead to keep out dirt. The inner parts of the J-30A have a special rust-resistant coating that aids "breaking-in" and eliminates storage greasing. *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

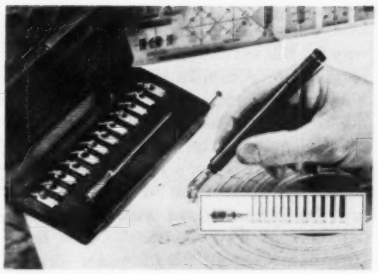
IMPROVEMENTS in the metal finish of packing and scraper rings that are used in floating metal packing of compressors handling air and industrial gases, have been announced by The Garlock Packing Company. The rings have a finish of less than 10 microinches on



the annular surfaces, whereas previous ones had a finish of 30 to 40 microinches. They are also flat within light band readings and, it is said, provide more perfect sealing over a broader range of applications. These improvements are now standard on all production rings. *The Garlock Packing Company*, 418 Main Street, Palmyra, N. Y.

OMNIGRAPHOS is the name of a specialized pen kit designed to increase speed and uniformity when used with schematic drawing templates. The kit

"You're our key salesman Peters — without you, our map would fall."



has a fountain-barrelled pen with twelve tubular nibs able to draw or match ink lines from 0.3 to 2.5 mm in width, regardless of the curves of the template. The offset angle of the interchangeable nibs is said to permit them to hug guide slot walls tightly, increasing speed and accuracy. *Laramie Chemical Corporation*, 290 Main Street, Stamford, Conn.

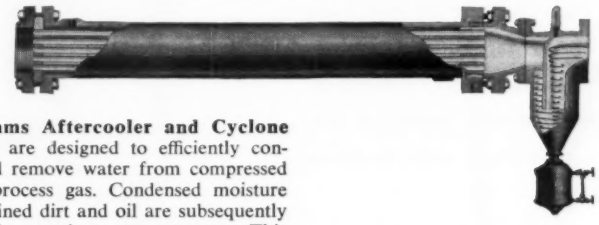
FIRST AID packets, in a system called C-Thru, can be checked visually through plastic windows that make up the wrappings. Antiseptics and burn ointments, for example, are contained in transparent tubes which the manufacturer calls Swabettes and Unettes. Included in the Swabette units are iodine, isodine, merthiolate and other popular antiseptics. Unettes contain a single application of a burn ointment such as boric acid, petrolatum and tannoid. All have an easy-to-open pull tab with a continuous red line to indicate an open package. The scored cover to the packets can be

folded back to uncover the contents for easy access. A wound cleanser is put up in a larger transparent plastic tube. *Davis Emergency Equipment Company*, 47 Halleck Street, Newark, N. J.

VERNIER calipers of stainless steel with a special finish called Lustro Chrome have been developed by George Scherr Company. The dull finish is said to take the glare out of caliper reading and make measuring to 0.001 inch instantaneous and accurate, even in poor light. An innovation is the

Aftercooler and Cyclone Separator designed for cleaner, dryer compressed air

R. P. ADAMS CO., INC.
209 East Park Drive, Buffalo 17, New York



The Adams Aftercooler and Cyclone Separator are designed to efficiently condense and remove water from compressed air and process gas. Condensed moisture and entrained dirt and oil are subsequently removed in a cyclone type separator. This unit is scientifically designed for maximum removal efficiency over a wide range of flow rates.

For normal use, units are available to cool gases to within 10° F of the temperature of the cooling water. Specially designed units are available to permit a 2° F approach to cooling water temperature, for application where low moisture content is critical.

Adams Aftercoolers and Separators are available from stock to handle 20 - 40,000 cfm with 10° cooling and 25 - 19,200 cfm where it is necessary to cool within 2°F of the cooling water. Special units can be supplied to suit an unlimited range of requirements. In all cases the maximum pressure loss at rated capacities is ½ psi.

This wide range of sizes enables the economical utilization of Adams Aftercoolers and Separators in virtually all industrial application. For further information on how R. P. Adams' units will solve your compressed air problems and save you money, write today for Bulletin 711.

raised-edge design that acts as a guideway for the vernier scale and was created to give protection to the finish. A double-length vernier has been added to make reading easier. Two models are offered, one for the shop and the other for the toolmaker. The former is designed for measuring of outside, inside and depth dimensions with a measuring capacity of $5\frac{5}{16}$ inches. Cross horns permit measuring the diameter of small holes and the distance between. The latter has extra-long jaws and a sensitive, fine adjustment screw. It is available with 8-, 10- and 12-inch measuring capacities. Both instruments have graduations on the lower and upper scales of 0.001 and 1/128 inch, respectively. *George Scherr Company, Inc.*, 200 Lafayette Street, New York 12, N. Y.

INTERCHANGEABLE elements are a feature of a dual-purpose automatic filter announced by Bowser. Two elements are available for the unit: one designed to clean lubricating oils and similar liquids; and the other, for filtering coolants. The former is constructed of wire-wound stainless steel or bronze, wrapped around a cast iron core with a port opening of 0.002 to 0.015 inch. Media for filtering coolants utilize a perforated brass sheet that has a porosity range of 0.02 to 0.045 inch. A timer provides automatic self-cleaning and

permits adjustment of the cleaning cycle from 20 seconds to 30 minutes. The longer ones are possible, it is said, because of a large sump located beneath the filtering units. Filters are available for handling flows from 120 to 1200 gpm. *Bowser, Inc.*, Lubrication and Filtration Division, 1300 East Creighton Avenue, Fort Wayne, Ind.

Industrial Literature

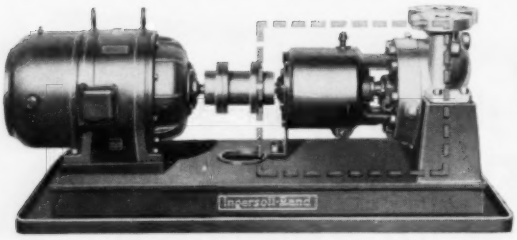
GAS ENGINES with 4-cycle, V-angle operation, designed for supplying power to industry, are the subjects of three fliers published by Ingersoll-Rand Company. The units are the PJVG, with a 220-295-hp range; the PSVG, with a 408-816-hp range; and the PKVG, with an 880-1760-hp range. The machines are built for dependable continuous service at either partial or full load and speed. Essentially, they are the same engines that power Ingersoll-Rand's compressors with the same letter designations, less the prefix "P." The manufacturer claims the units' smooth-running operation makes them ideal for driving alternating current generators, and that they are well-suited to act as prime movers for pumps, blowers and the like. The fliers describing the engines, numbered sequentially from smallest to largest machine, are: Forms 10051 (PJVG); 10052 (PSVG), 10053 (PKVG). *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

PNEUMATIC power actuators, Conoflow Series 50 cylinder Conomotor units, are explained in a 12-page bulletin (B-50-3). They are said to be widely used in the process industries for throttling control service. The brochure lists applications for the devices, including proportional control of different types of valves, speed changers, pumps, rheostats, autotransformers, flow regulators and the like. More than twenty applications are illustrated. *Conoflow Corporation*, 2100 Arch Street, Philadelphia 3, Pa.

INFORMATION on five basic timing belt pitches has been gathered into one catalogue (TB-58). The 67-page publication contains engineering information as well as data about the pitches of 1/5-, 3/8-, 1/2-, 7/8- and 1 1/4-inch belts. Selection, installation and the use of these lubrication-free drives is indexed. *Morse Chain Company*, Ithaca, N. Y.

BLASTING CAPS are described in a pocket-sized booklet complete with colored, cross-section drawings. Included are safety fuse and electric caps for general, as well as special-purpose, use. Blasting supplies and accessories are also listed in the publication (Form 200-77A). *Hercules Powder Company*, 900 Market Street, Wilmington 99, Del.

POROUS, sintered stainless steel filters are described and illustrated in a 12-page catalogue, No. 54-101, which pro-

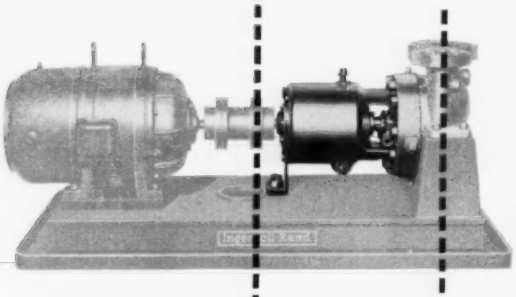


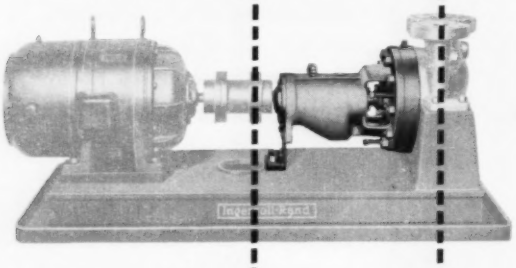
This "multi-process" pump

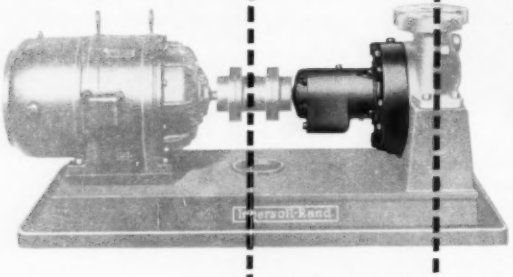
now handles

a wider range of applications

with unequalled interchangeability of parts







Here's how Ingersoll-Rand "tailors" its SFL line of heavy-duty pumps to meet your process requirements at least cost:

SFL . . . high-temperature service up to 800°F.
This is the basic water-cooled heavy-duty pump which has gained industry-wide acceptance for ruggedness and long-term dependability. It is designed specifically for hot-liquid services and is available with packed box or mechanical seals.

SFLM . . . medium temperature up to 300°F.
Take away the water-jacketing from the SFL and you have the SFLM . . . the same rugged pump *at a lower first cost*, designed for medium-temperature service. Should you later decide to put this pump on high-temperature service, *you can easily convert it to water-cooled operation.* Simply change to a water-cooled stuffing box extension and bearing housing. Available with packed box or mechanical seal.

SFLA . . . up to 200°F . . . with built-in mechanical shaft seal as standard equipment.
The seal eliminates packing maintenance and permits complete enclosure of the seal box . . . a definite safety factor. Within its rating, the SFLA is the most economical selection with single mechanical seal.

3 designs for one basic pump...
all available with top or end suction for heads to 750 ft, capacities to 900 gpm

WITH Ingersoll-Rand's newly extended line of "multi-process" pumps, you can now select from three basic types . . . and get exactly the pump you want for each specific application. You get maximum interchangeability of parts, plus the first-cost economy which results from a basically *standard* production model.

Whether your process can be best served by one of these "multi-process" pumps or by other models manufactured by Ingersoll-Rand, you can be sure that your I-R pump specialist will give you objective, expert counsel. Ingersoll-Rand makes *the most complete line of centrifugal pumps* available for the process industries.

Ingersoll-Rand

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THERE'S NO SUBSTITUTE FOR EXPERIENCE IN ENGINEERED PRODUCTS

vides characteristics, application data and specifications of filter media. A chart with instructions, and filtration-data tables are added features that help in filter selection. *Cuno Engineering Corporation*, Meriden, Conn.

STEEL shaft collars for applications in movie projectors and sound equipment, industrial and textile machinery and on printing presses, materials-handling equipment and other machinery are shown in a 4-page bulletin. The flyer also reviews construction details and specification information on the collars available in 43 standard sizes for shafts ranging from ⅛ to 3 inches in diameter. *Standard Pressed Steel Company*, Jenkintown, Pa.

FOLLOWING a survey of the construction and mining industries, a 12-page brochure, *Specialty Steels for the Heavy Construction and Mining Industry*, was prepared to suggest the application of these steels as an aid toward better and more efficient production. Various grades of alloy, carbon, drill, stainless and tool steels, together with castings, welding electrodes, magnets, springs and tool bits, are discussed. *Crucible Steel Company of America*, Oliver Building, Pittsburgh, 22, Pa.

RUBBERIZED abrasives for deburring, smoothing and polishing are explained in an 8-page publication that tells what Cratex rubberized abrasives are, and how they are used in precision manufacturing of tools, dies, molds, instruments, models and the like. Advanced application information, operating instructions, tables and illustrations are also included. *Cratex Manufacturing Company*, 1600 Rollins Road, Burlingame, Calif.

GOODYEAR Tire & Rubber Company has published a 16-page booklet entitled *V-Belts, The Testing, Inspection And Control Of Their Quality* (S-51107). It is the fourth in a series and describes in words and with pictures how raw materials and finished belts are tested and inspected. One section explains quality control procedures, another is concerned with experimental production. *Goodyear Tire & Rubber Company*, Akron 16, Ohio.

HIGH-RELIABILITY gauges are outlined in a 48-page catalogue. Pressure ranges are from 15 psig, or 30 inches of vacuum, to 20,000 psig, and the devices may be used in air, gas, vapor and liquid applications. *Kunkle Valve Company*, 120 South Clinton, Fort Wayne, Ind.

The Eimco 630 Excavator **High Capacity Loading, rugged construction and low maintenance costs.**

"YOU CAN'T BEAT AN EIMCO"

This phrase, coined by thousands of Eimco users since Eimco introduced successful overhead loading 26 years ago, and used in mines throughout the world has been earned through an unexcelled, honest and dependable performance by machines always assigned to the task of hard severe service.

Robust, gadget-free, hell-for-stout construction that is typical of all Eimco Loaders is also found in the 630, pioneered by Eimco for every phase of trackless underground work.

Today the results speak for themselves. Hundreds of repeat orders from customers who have learned through their own experience — that the statement "You can't beat an Eimco" is a true fact.

An Eimco 630, similar to the machine pictured above, has loaded more than 375,000 tons at a verified average cost for maintenance of only 2.9 cents per ton loaded.

Yes! This is the type of heavy-duty equipment you get from Eimco — this is the equipment to buy to meet low metal prices and show a profit.

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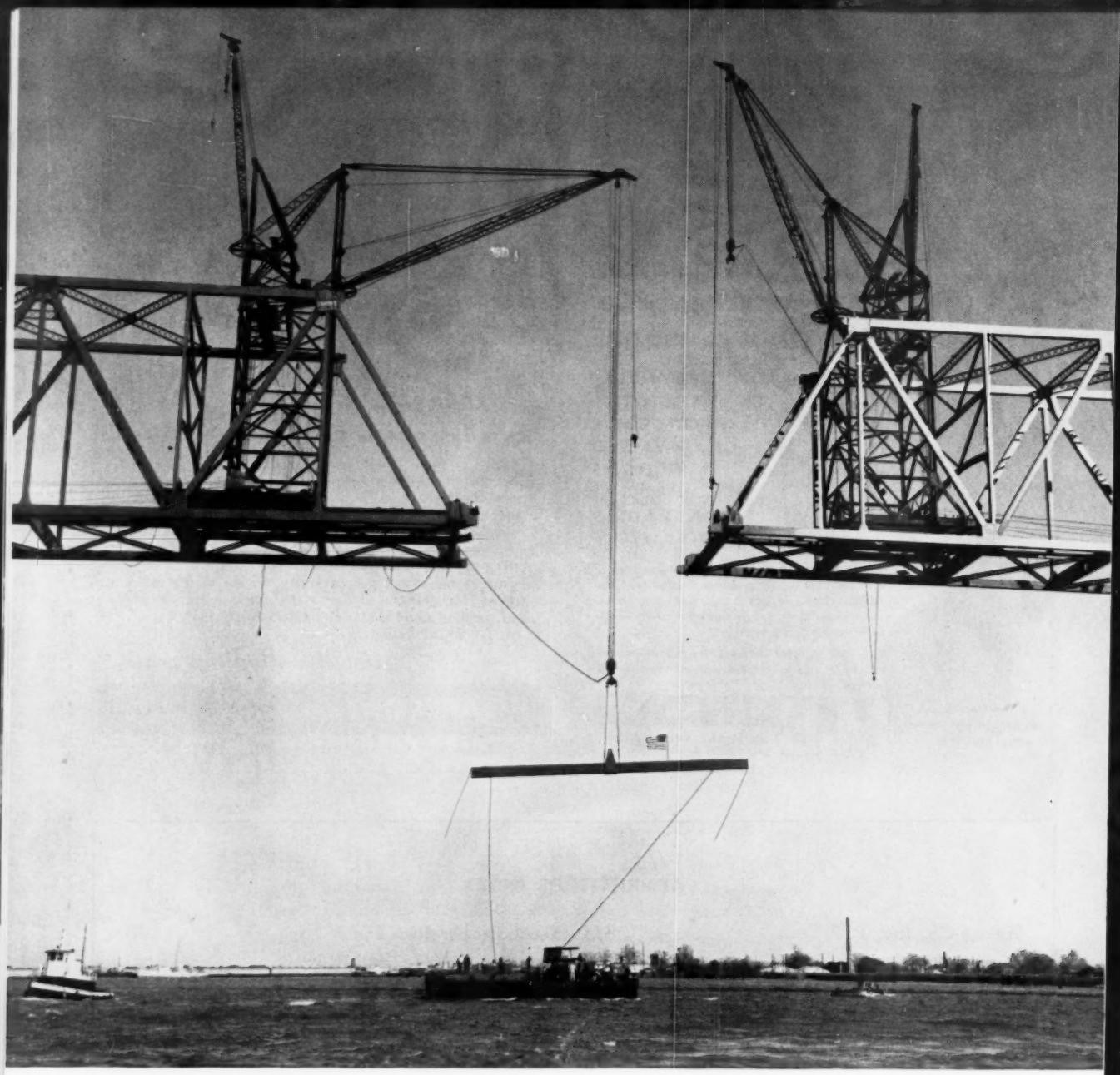


Nation's Longest Cantilever Span at New Orleans. It's said that a downtown bridge across Ol' Man River has been a cherished dream in New Orleans for more than a century. Now they have their bridge, a tremendous structure that links the City of New Orleans with Algiers, on the opposite bank of the Mississippi. Its center span is the longest and perhaps the most spectacular cantilever span in the country.

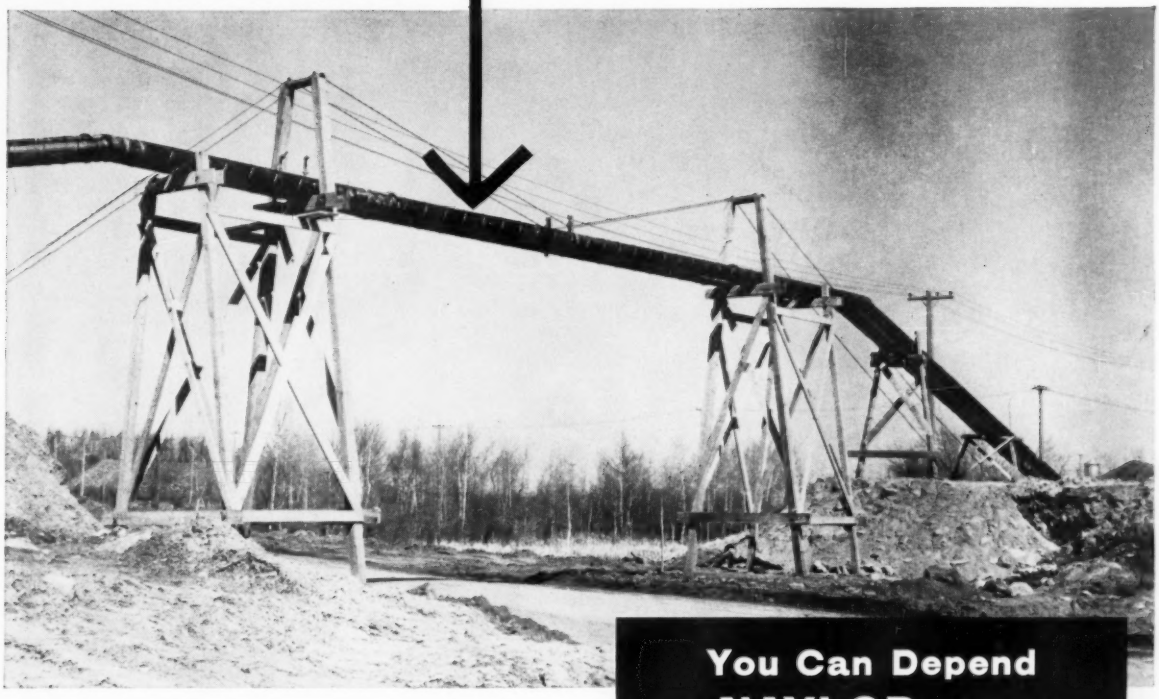
The picture shown here was taken early in 1958, when the history-making bridge was nearing completion. Scenes like this—with steel rope lifting and maneuvering heavy structural members—were part of the daily drama. Thousands of feet of husky Purple Strand, Bethlehem's finest wire rope, were used to speed the construction work, which at times required lifts of 90 tons or more.

Bethlehem Steel Company, Bethlehem, Pa. On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Mill depots and distributors from coast to coast stock Bethlehem rope for the following industries and numerous others:

CONSTRUCTION • EXCAVATING • MINING • QUARRYING • PETROLEUM • LOGGING • MANUFACTURING

Always a GREEN LIGHT!



You Can Depend on NAYLOR Pipe for UNINTERRUPTED PERFORMANCE

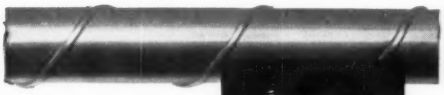
There's smooth going through lines of NAYLOR Spiralweld pipe.

One of the advantages of NAYLOR'S exclusive spiral-lockseam structure is its factor of "give" which assures closer conformity to topographical conditions without any sacrifice of strength. This enables you to make up your lines quickly, regardless of terrain or man-made obstructions.

Along with the extra strength and safety built into this pipe is its light weight which simplifies handling and speeds installation. You save even more time and work when you use the one-piece NAYLOR Wedgelock coupling for connections.

For savings in time, work and money—it will pay you to specify NAYLOR pipe for dependable transportation of water and air, and for dredging, materials handling, ventilating and other services.

Write for Bulletin No. 507



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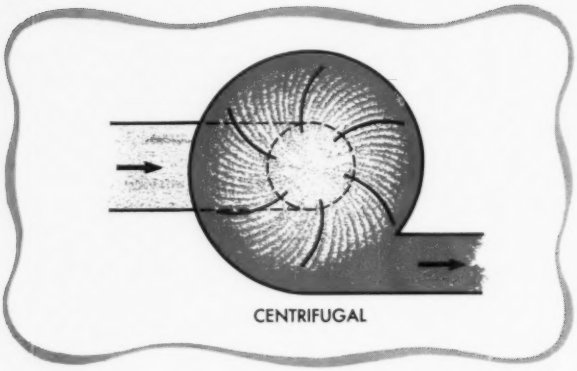
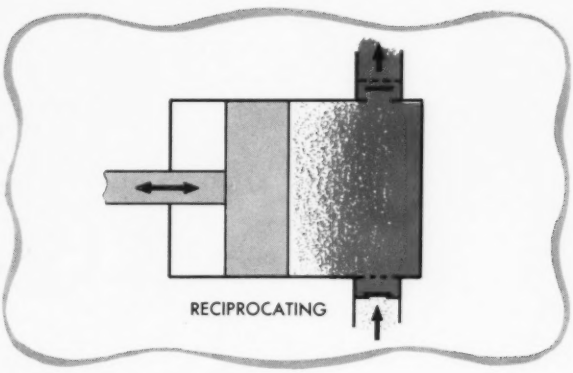
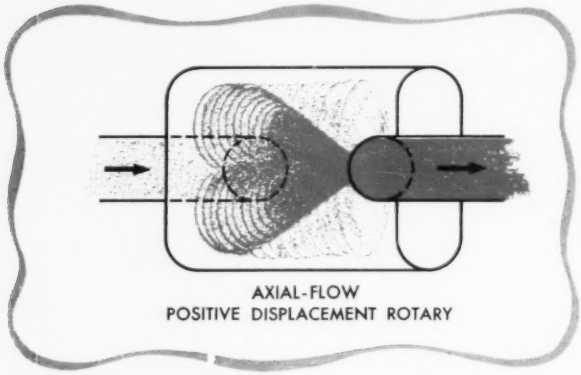
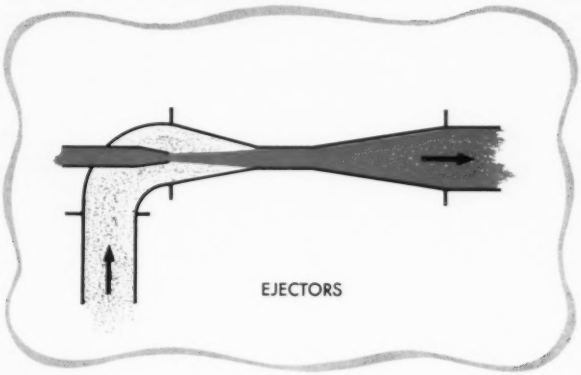






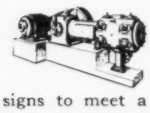


Which method is best for your PRESSURE or VACUUM requirements?

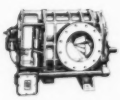
AIR or any other gas behaves differently under each of these methods of compression or evacuation. But for any set of operating conditions, *one method* will have advantages that make it the most practical and economical solution to the problem.

Ingersoll-Rand, the only manufacturer of *all four types* of compressors, is in a unique position to help you select the most efficient unit for any job. Here are a few general comments on each type.

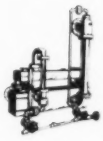
Centrifugal Compressors. Ingersoll-Rand centrifugal blowers and compressors are available in single- and multi-stage units, for handling large volumes of air and all other gases at vacuum and for pressures up to 2500 psi and higher. Sizes range up to 20,000 hp and capacities to 300,000 cfm. They can be driven by steam turbine, electric motor, combustion-gas turbine and hot-gas expander turbine.



Reciprocating Compressors. I-R reciprocating compressors are available in single- and multi-cylinder designs to meet a wide range of high-pressure, low-volume requirements. They have been furnished in sizes from ½ to 7,500 hp, for pressures to 35,000 psi and vacuums. Driver types may be electric, steam, oil or gas, and oil-free air can be provided by means of Type NL non-lubricated cylinders and valves.



Axi-Compressors. The Ingersoll-Rand Axi-Compressor is a compact, space-saving axial-flow positive displacement rotary compressor that offers unique advantages within its operating range. It delivers a steady flow of clean, oil-free air or gas and can be direct driven by electric motors or gasoline engines. Available in capacities from 100 to 12,000 cfm for pressures to 15 psi and vacuums to 15″ hg. Higher vacuums can be produced with water injection or with two stage units.



Ejectors. For many applications, I-R ejectors offer maximum simplicity and economy, as they have no moving parts and require practically no attention or maintenance. They can be supplied for vacuums to 5 microns (0.000197″ hg abs), as well as for pressures to 150 psig.

• • •

Your Ingersoll-Rand representative will be glad to give you complete information on any of these compressor or vacuum units — and help you select the one that's best suited to your particular requirements.

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There's no substitute for experience in engineered products